



Wireless Security System

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Graduation Project Report

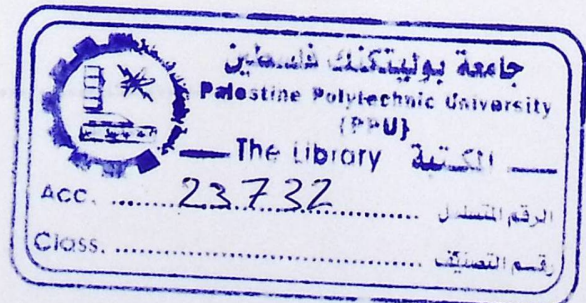
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جامعة بوليتكنك فلسطين
الخليل-فلسطين
كلية الهندسة و التكنولوجيا
دائرة الهندسة الكهربائية والحاسوب

اسم المشروع

Wireless Security System

أسماء الطلبة

وهيبة "محمد عمر" بغمور

سوسن إبراهيم أبو شرح

بناءً على نظام كلية الهندسة والتكنولوجيا وإشراف ومتابعة المشرف المباشر على المشروع وموافقة أعضاء اللجنة الممتحنة تم تقديم هذا المشروع إلى دائرة الهندسة الكهربائية والحاسوب، وذلك للوفاء بمتطلبات درجة البكالوريوس في الهندسة تخصص هندسة أنظمة الحاسوب.

توقيع المشرف

.....

توقيع اللجنة الممتحنة

.....

توقيع رئيس الدائرة

.....

DEDICATION

All praise be to Allah
To those who give of themselves
So that others may live

The most deserving of our acknowledgments is our respected supervisor ENGI. LIANA JALAL who helped us throughout the research of the present project. Next we want to express our deepest gratitude to our friends DHAR AL-KABASHI and MORANIMAD ABO-ALAMIA for taking all the pains to help us in troubleshooting and give us some valuable tips. Thanks are also due to our families for their encouragement, prayer or advice might have contributed directly or indirectly towards the actualization of this work. Last but not the least we would like to thank the cooperative laboratory of the Faculty of Engineering, Assiut University for the library facilities.

To our Families for their patience

To our Colleagues for their support and encouragement

To our Supervisor Eng. Liana Jalal for her supports and advices

Waheda M.O Yeghmour
Waheda M.O Yeghmour

Date: 30/05/2007

ABSTRACT
ACKNOWLEDGMENT

Wireless Security System

Project Team:

All praise be to Allah The Ultimate Guide and The Cherisher who gave us the courage and ability to complete this project with a satisfying degree of perfection. The most deserving of our acknowledgments is our respected supervisor **ENG. LIANA JALAL** who helped us throughout the research of the present project. Next we want to express our deepest gratitude to our friends **OMAR AL-KABABJI** and **MOHAMMAD ABU-AJAMIA** for taking all the pains to help us in troubleshooting and give us some valuable tips. Thanks are also due to all those who by way of encouragement, prayer or advice might have contributed directly or indirectly towards the actualization of this work. Last but not the least we would also like to thank the cooperative laboratory instructor Ala'a Al-Tamimi for letting us to use the facilities at the library freely.

Sawsan I. Abu Sharkh

Waheeba M.O Yeghmour

Dated: 30/05/2007

ABSTRACT

Wireless Security System

Project Team:

Sawsan I. Abu-Sharkh
Waheeba M.O Yeghmour

Palestine Polytechnic University

Supervisor:
Eng. Liana Jalal

Today, the wireless technology has become very ordinary. The widespread of this technology makes many applications use it. One of those applications is security systems.

Having a wireless security system in such way to protect small residential areas such as small departments or rooms, by sensing a person come close will give you warning and enough time to react to the visitor, whether or not to allow him/her to enter.

This system will be useful at different situations, for example, consider you are in a research lab that handles highly hazardous material. You don't want anybody to enter the room, or even come close to the door. Or consider yourself doing something highly confidential in a room that you would like to know if someone is trying to get in.

الملخص

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التكنولوجيا اللاسلكية أصبحت شائعة هذه الأيام. الانتشار السريع لهذه التكنولوجيا في العديد من التطبيقات، من إحدى هذه التطبيقات أنظمة الحماية والأمن.

أن يكون هناك نظام أمن لاسلكي لحماية مناطق صغيرة نسبياً مثل شقة أو غرفة، من خلال استشعار أي شخص يحاول الاقتراب أو الدخول للمنطقة المحمية عن طريق إرسال تنبيه بوجود محاولة اختراق مع توفير الوقت الكافي للتعامل مع المخترق.

سيكون هذا النظام مفيد في عديد من الأوضاع، من الأمثلة على ذلك: اعتبر نفسك داخل مختبر يحتوي على العديد من المواد الخطرة ولا تريد السماح لأحد الدخول أو حتى الاقتراب من هذه المنطقة. أو تخيل نفسك تقوم بعمل في غاية السرية وتريد معرفة من يحاول الاقتراب.

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Chapter

1.1 Overview

1

Introduction

Today, the wireless technology has become very ordinary. The widespread of this technology makes many applications use it. One of those applications is security systems.

1.1 Overview.

1.2 Literature Review.

1.3 Project Scheduling.

1.4 Estimated Cost and Budget Breakdown.

1.5 Project Risk Management.

1.6 Report Road Map.

We aim at designing and implementing a security system. It includes two or more sensors, which will be placed at the door that is able to sense a person trying to open it, and then the system will give you a warning and the time to check the key of any intrusion.

Chapter One

Introduction

1.1 Overview

Today, the wireless technology has become very ordinary. The widespread of this technology makes many applications use it. One of those applications is security systems.

The home or office should be your haven where you feel comfortable and secure. Combining technology and trusted quality, a wireless security system is a proven deterrent to intruders. The system provides you with excellent alternatives along with peace of mind.

Suppose you are in a place and you do not want anybody to enter it, or even to come close to the door, or consider yourself doing something highly confidential in a room that you would like to know if someone is trying to get in. In all these situations would find that, a wireless security system is useful.

We aim at designing and implementing a security system. It includes two or more sensors, which will be placed at the door that is able to sense a person trying to open it, and then the system will give you a warning and the time to check the try of any intrusion.

A personal computer (PC) is used as an administrator to stop the alarm if any of the security sensors is triggered, in addition; a microcontroller unit (MCU) such as PIC will be connected to detection and transmitter units. A wireless radio frequency (RF) transmitter / receiver will be used to transfer the state of the environment.

1.2 Literature Review

A previous study on wireless security system states: Create a home security system to protect homeowners from intruders. The prototype that was created can be easily scaled in terms of the amount of sensors and their placement. These sensors would be placed throughout the house at all possible entryways such as windows and doors. Those attempting to enter the house while the system is armed will trip any one of these sensors and consequently set off the alarm. (Nayak and Bodruzic, 2003).

1.3 Project Schedule

The time planning includes two time estimation schedules; the first one show what has been done in the first semester, and the second shows the scheduling time of the second semester. This time management clarifies each step of the project and guarantees the full completion of the overall system.

The timing management divides the system hierarchy according to the actions:

T1: *Preparing to the project.* this stage of the project primarily aims at identifying the contents of it, discussing the initial information, and evaluating the project tasks and levels.

T2: *The project analysis.* the analysis process includes extensive study for all possible design options of the project.

T3: *The project requirements analysis.* tasks have to be implemented, equipments are needed to be provided, and data should be processed.

T4: *Studying the foundation of wireless technology.* understanding the transmission and receiving circuits.

T5: *Studying the MCU and sensors.* it was necessary to study the datasheet of the PIC to ensure that it would meet the requirements of the project.

T6: *Writing the documentation.* the writing began from the first phase to the last one in parallel.

Table (1.1): The Task Duration

T7: *Constructing the Circuits and Connections:* hardware implementation of the circuits that represent the system and subsystems of our project. It was started by building prototypes.

T8: *Sub-System Testing:* at that stage, we tested each component of the project and also each subsystem.

T9: *Software Implementation:* it was started with downloading the program of the PIC. In addition, a small program in JAVA programming language was used to implement the PC parallel port.

T10: *Software Testing:* after completing the whole software, it was tested to check if the hardware was running appropriately.

T11: *Overall System Testing:* we tested the project and implemented it to adjust the problems and errors and maintain it.

T12: *Final Documentation writing:* the writing process and the implementation of the different stages of the project were done in parallel, in order to keep track on what had been done.

Fig. (1.1): Project Activity Network

Table (1.1): The Task Duration

Task	Duration(weeks)	Dependencies
T1	3	-----
T2	3	-----
T3	4	T1,T2
T4	5	T3
T5	2	T3
T6	15	T4, T5
T7	5	
T8	4	T7
T9	5	T7
T10	4	T9
T11	11	T8, T10
T12	15	-----

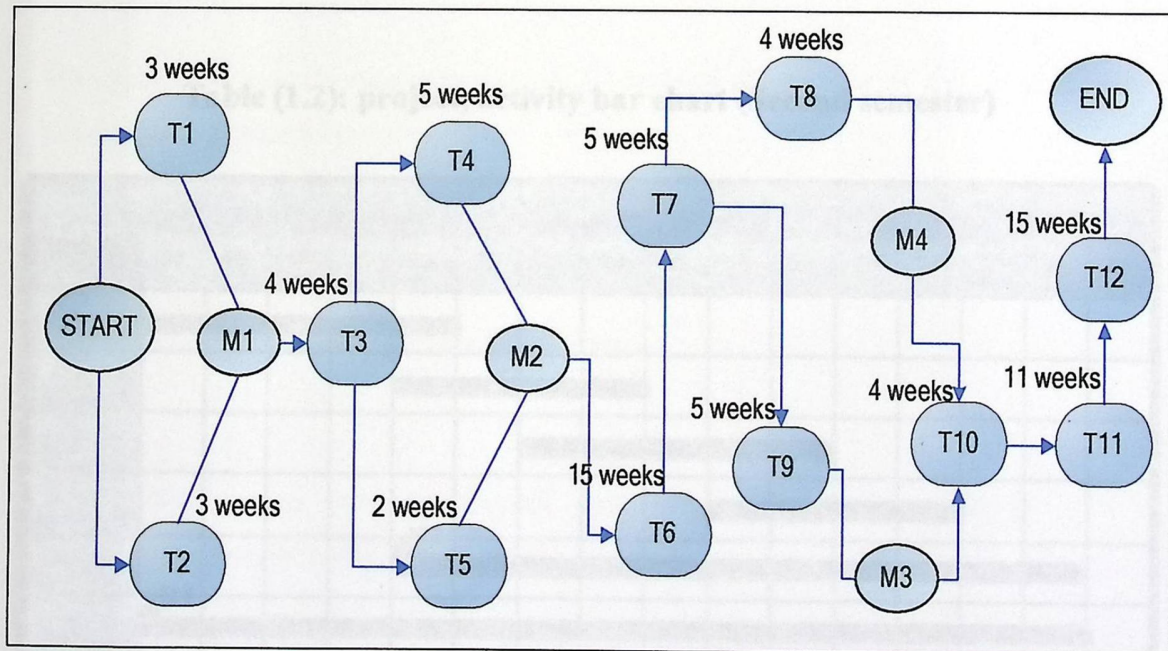
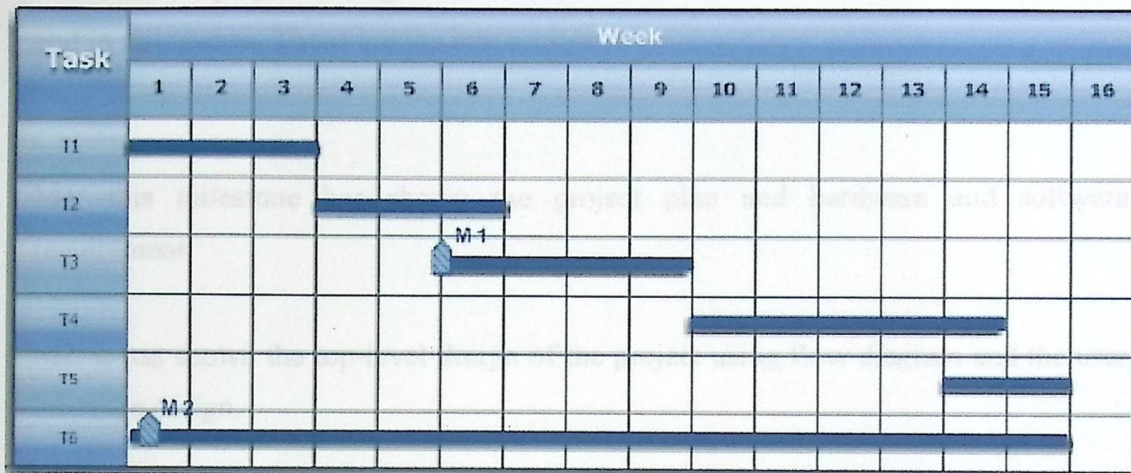


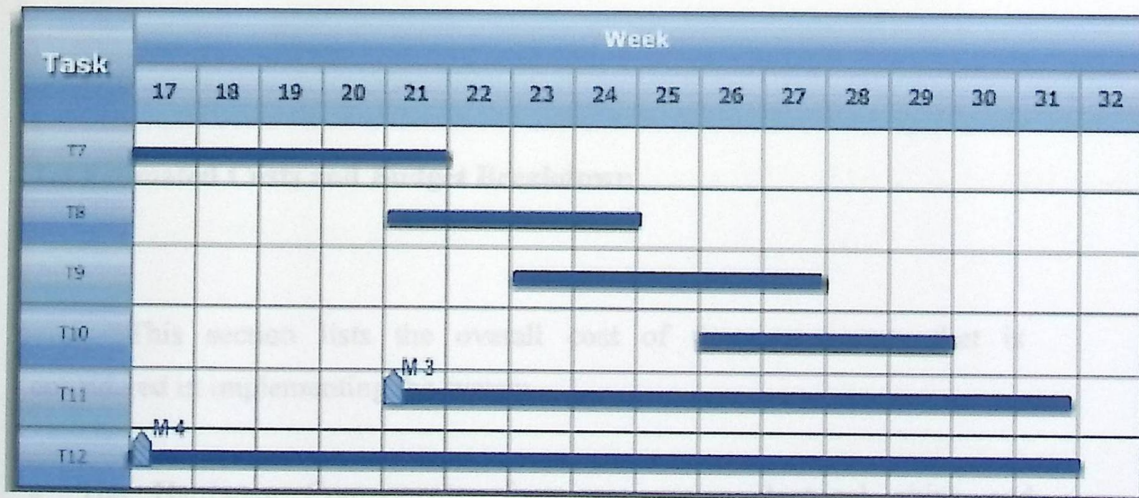
Fig. (1.1): Project Activity Network

Table (1.2): Project, Activity Bar Chart (First semester)



M3: it has provided the hardware construction, required components, subsystems, and migration tests.

Table (1.2): project, activity bar chart (Second semester)



equipment's have to be provided are listed in Table (1.3).

In the project management tool used to produce this chart, all activities must end in milestones. Those are the basic milestones:

PC 1054	10.00
Receiver	18.00
Transmitter	18.00
Power Supply	2.00
Printer Cable	3.00
Decoder	3.00

M1: this milestone has shown the project plan and hardware and software requirement.

M2: it has shown the top-level design of the project using flow diagram and the user interface design.

M3: it has presented the hardware constructing, covered components, subsystems, and integration tests.

M4: project documentation was prepared, covered all aspects of the project, and pointed to the project completion.

1.4 Estimated Costs and Budget Breakdown

This section lists the overall cost of the components that is considered in implementing the system.

- The Hardware Components, there are many electrical chips and equipments have to be provided are listed in Table (1.3).

Table (1.3): Project Cost

Component	Cost (\$)
PIC 16F84	10.00
Receiver	18.00
Transmitter	18.00
PIR sensor	15.00
Bump Sensor	2.00
Printer Cable	5.00
Decoder	3.00
Encoder	3.00

The approximated total cost for the project is \$68.

1.5 Project Risk Management

During the implementation of the different phases of the project, many problems and risks have to be identified and solved in the early time of the project designing and manipulation. This should be done in order to operate the project in efficiently and effectively manner.

1.5.1 Hardware Risks

- Device failure: the microcontroller may crash because of high voltage supply or other problems.

- The device operates differently from what expected.
- The receiver circuit does not respond.
- The needed time for response is so long that makes the user nervous.

In addition to these risks, other component risks may appear such as:

- Demand device at earlier time.
- Start working on the implementation earlier.
- Use alternate devices with the same functionality and less cost.
- Try to build our own circuits that can replace unavailable devices.
- Improper readings of sensors.
- An addition of noise from the outer environment.

1.5.2 Group Risks

- Illness of one or more of group members.
- Group meeting difficulties

1.5.3 Project risks:

- Inaccurate schedule.
- Insufficient budget.

- Supervisor change.
- Latency of devices arrival.

Recovery:

- Demand device at earlier time.
- Start working on the implementation earlier.
- Use alternate devices with the same functionality and less cost.
- Try to build our own circuits that can replace unavailable devices.

1.6 Report Road Map

The documentation for this project is divided into five chapters. Each chapter concerns with a logical or physical part of the system. The followings explain briefly the contents of each chapter:

Chapter 1: Introduction

This chapter presents overview, literature review, group dependency, project scheduling, and estimated cost.

Chapter 2: Theoretical Background

This chapter discusses in details the basic components used in the project and theoretical back ground.

Chapter 3: Project Conceptual Design

This chapter explains the design concepts, introduces project objectives, shows the general block diagram of the system, and explains how system works.

Chapter 4: Detailed Technical Project Design

This chapter presents out lines formal procedure for design, discusses design options and justifies those chosen for the project.

Chapter 5: Software System Design

This chapter handles the software related to our system, depicts flowcharts about system operation.

Chapter 6: System implementation and Testing

This chapter manifests the implementation procedures to be done integrate the project. Then, a sequence of procedural testing will be listed. The testing comprises both software and hardware testing.

Chapter 7: Conclusion and Future work

This chapter provides the conclusions that will be concluded after working the system, and suggestion for future work.

- 2.1 Theoretical Background Related to the Main Idea of Project.
- 2.2 Hardware Related to the Project.
- 2.3 Project Integrity.
- 2.4 Theoretical Background about Project Components.

Chapter Two
Theoretical Background

Chapter

2 Theoretical Background

2.1 Theoretical Background Related to the Project

As mentioned in the previous chapter, the project is fully constructed over a communication system. The main idea of the project is to provide a communication system.

2.1 Theoretical Background Related to the Main Idea of Project.

2.2 Hardware Related to the Project.

The term wireless is normally used to refer to any type of electrical or electronic communication system that does not require the use of a "hard-wired" connection, though they may be accomplished with the use of wires if desired. In addition, the term wireless communication is used to refer to any type of communication system that does not require the use of electrical conductors or wires.

2.3 Project Integrity.

2.4 Theoretical Background about Project Components.

Wireless communication involves:

- Radio Frequency communication.

Chapter Two

Theoretical Background

This chapter provides an illustrative theoretical background for our project applications in general and for its each component in particularly.

2.1 Theoretical Background Related to the Project.

As mentioned I the previous chapters, the project is fully constructed over a communication between the door and PC, and a RF signal is used to establish the communication.

The term wireless is normally used to refer to any type of electrical or electronic operation that is accomplished without the use of a "hard wired" connection, though they may be accomplished with the use of wires if desired. In addition, the wireless communication is the transfer of *information* over a distance without the use of electrical conductors or wires.

Wireless communication involves:

- Radio Frequency communication.

- Microwave communication, for example long-range line-of-sight via highly directional antennas, or short-range communication.
- Infrared (IR) short-range communication.

Now, we will introduce the types of transmission signals and the comparison between them.

- **Ultrasound:**

Ultrasound is sound of such high frequency, that is, it can not be heard by the human ear. Atypical ultrasound transducer operates at a frequency of 40 KHz but the ear can hear up to 20KHz. Ultrasound transducer is relatively inexpensive and the circuit required is simple to build.

- **Radio Frequency (RF):**

Radio frequency, or RF, refers to that portion of the electromagnetic spectrum in which electromagnetic waves can be generated by alternating current fed to an antenna. Such frequencies and the belonging wavelength account for the following parts of the spectrum shown in the table below.

Radio control has the advantage of the operating over a far greater

range than ultrasound, also it does not required the physical connection as in the cable control, it is very popular for the control of aircraft's, boat's.....etc.

- **Bluetooth**

Bluetooth is a radio standard and communications protocol primarily designed for low power consumption, with a short range (power class dependent: 1 meter, 10 meters, 100 meters) based around low-cost transceiver microchips in each device.

Bluetooth lets these devices communicate with each other when they are in range. The devices use a radio communications system, so they do not have to be in line of sight of each other, and can even be in other rooms, so long as the received transmission is powerful enough.

- **Infrared (IR):**

Infrared (IR) is a light-based transmission technology and is not spread spectrum—spread spectrum technologies all use RF radiation. IR devices can achieve a maximum data rate of 4 Mbps at close range, but as a light-based technology, other sources of IR light can interfere with IR transmissions. The typical data rate of an IR device is about 115 kbps, which is good for exchanging data between handheld devices. An important advantage of IR networks is that they do not interfere with spread spectrum RF networks. For this reason, the two are complementary and can easily be used together.

- **Comparison between Transmission Signals:**

The electromagnetic spectrum is depicted in Figure (2.1). A horizontal bar represents a range of frequencies from 10 Hertz (cycles per second) to 10^{18} Hertz. Some familiar allocated frequency bands are labeled on the spectrum. Approximate locations are as follows. (Exponential powers of 10 are abbreviated as 10exp).

10 Hertz: extremely low frequency or ELF.

10^5 Hertz: AM radio.

10^8 Hertz: FM radio.

10^{10} Hertz: Television.

10^{11} Hertz: Microwave.

10^{16} Hertz: Infrared (frequency range is below the visible light spectrum).

10^{16} Hertz: Visible Light.

10^{16} Hertz: Ultraviolet (frequency range is above the visible light spectrum).

10^{18} Hertz: X-rays.

2.2 Hardware Related to the Project.

Hardware components of the project are:

1. Microcontroller.
2. Transmitter.
3. Receiver.
4. Encoder and Decoder.
5. Sensors.

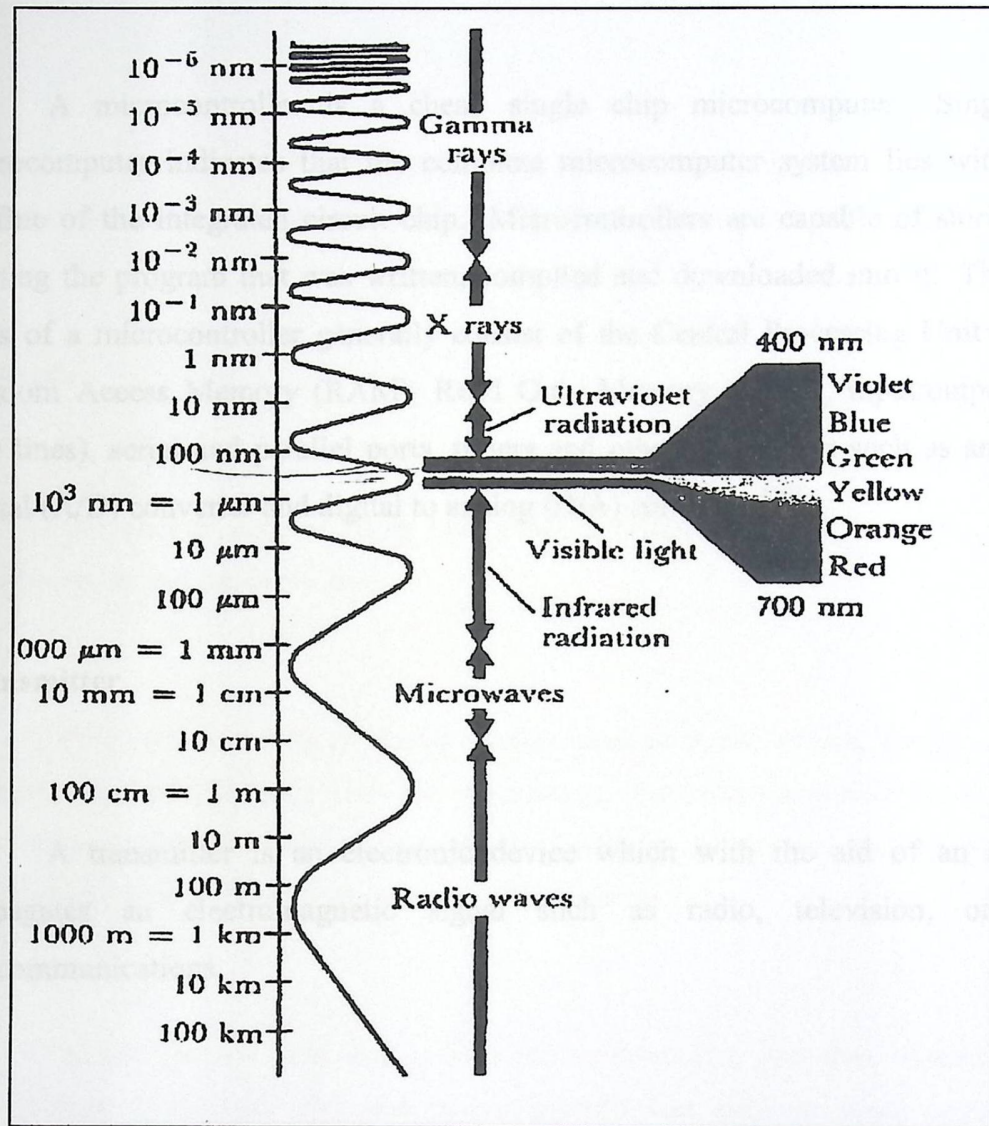


Fig (2.1): Electromagnetic Spectrum

Microcontroller

A microcontroller is a cheap single chip microcomputer. Single-chip microcomputer indicates that the complete microcomputer system lies within the confine of the integrated circuit chip. Microcontrollers are capable of storing and running the program that was written, compiled and downloaded into it. The main parts of a microcontroller generally consist of the Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM), input/output lines (I/O lines), serial and parallel ports, timers and other peripherals such as analog to digital (A/D) converter and digital to analog (D/A) converter.^[10]

Transmitter

A transmitter is an electronic device which with the aid of an antenna propagates an electromagnetic signal such as radio, television, or other telecommunications.

A transmitter usually has a power supply, an oscillator, a modulator, and amplifiers for audio frequency (AF) and radio frequency (RF). The modulator is the device that modulates the signal information onto the carrier frequency, which is then broadcast. Sometimes a device contains both a transmitter and a radio receiver, with the combined unit referred to as a transceiver.^[18]

Receiver

A receiver is an electronic circuit that receives a radio signal from an antenna and converts the signal into sound, pictures, navigational-position information, etc.

Sensors:

We classify sensors using two important functional axes: proprioceptive/ exteroceptive and passive/active.

Proprioceptive sensors measure values internal to the system. Exteroceptive sensors acquire information from the environment. Passive sensors measure ambient environmental energy entering the sensor. Examples of passive sensors include temperature probes, microphones, and CMOS cameras.

Active sensors emit energy into the environment, and then measure the environmental reaction. Because active sensors can manage more controlled interactions with the environment, they often achieve superior performance. However, active sensing introduces several risks: the outbound energy may affect the very characteristics that the sensor is attempting to measure. Furthermore, an active sensor may suffer from interference between its signal and those beyond its control.

There are many types of the sensors that can be used in the home. Some of these are very simple, and others can be very complex and expensive.

Encoder

An encoder is a device used to change a signal (such as a bit stream) or data into a code. The code may serve any of a number of purposes such as compressing information for transmission or storage, encrypting or adding redundancies to the input code, or translating from one code to another. This is usually done by means of a programmed algorithm, especially if any part is digital, while most analog encoding is done with analog circuitry.^[16]

Decoder

A decoder is a device used to in digital electronics this would mean that a decoder is a multiple-input, multiple-output logic circuit that converts coded inputs into coded outputs, where the input and output codes are different. e.g. n -to- 2^n , BCD decoders.^[16]

2.3 Project Integrity

Choosing the wireless technology in our project is a challenge for us since many previous projects in our university were based on the wireless technology and most of them did not achieve a complete success in the implementation. Therefore, the wireless communication is the most critical part of the system design.

2.4.1 RT4-XXX Transmitter

Our aim is to have a complete and integrated system at the end of this semester, so we did our best to achieve this by assuring the compatibility among the different chips we used and the high functionality of each of them.

Our proposed design is to use one transmission chip, RT4-433, and one receiver, the RR3-433, as well as a single encoder, HT12E, and one HT12D decoder. A microcontroller will be needed to set the appropriate bits of the encoder to be sent by the transmitter. Also, two sensors that its output digital so no analog to digital converter is needed; they are directly connected to the microcontroller. We chose those chips since the compatibility among them; we make sure of it by extensive study for each chip.

Fig. (2.3): RT4-433/92 Transmitter

Many factors went into decision of finalizing our design. After gathering information about feasibility, costs, and communication between devices, we opted to start from a simple design, prototype it, and, after evaluation, if we feel confident about it we could improve it.

We will explain all the levels of transmission process, as shown in the

2.4 Theoretical Background about Project Components.

In this section, we provide a full explanation of each component and each part of this project.

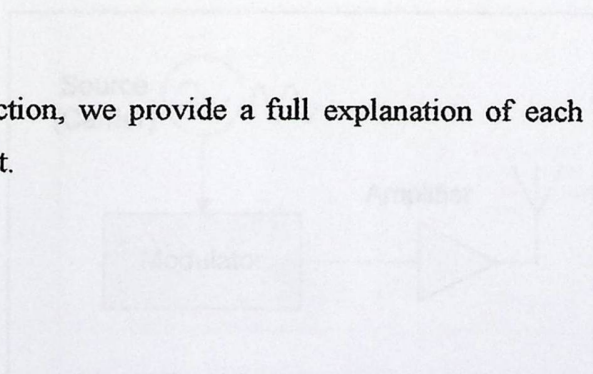


Fig. (2.3): Basic Transmitting Unit

2.4.1 RT4-XXX Transmitter

We use a RT4-XXX transmitter that is a hybrid circuit that allows realizing a complete radio transmitter.

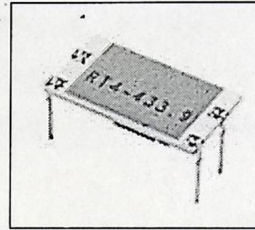


Fig. (2.2): RT4-433.92 Transmitter

It is a wireless (AM) transmitter with range up to 75m; it can be used in car alarm system or gate remote controlling. It is a complete RF transmitter with very stable frequency.^[9]

We will explain all the levels of transmission process, as shown in the Figure(2.3).

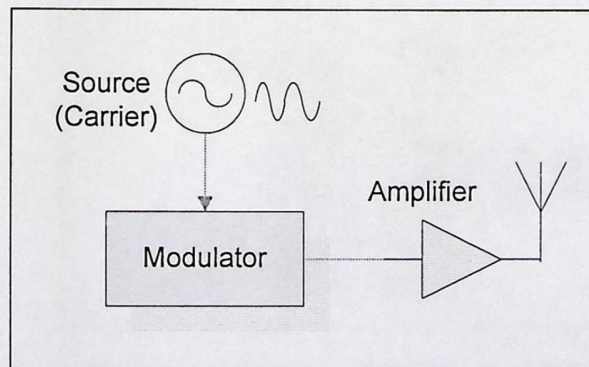


Fig (2.3): Basic Transmitting Unit

- **Frequency Source (Carrier):**

In order to make the information signal pass through the air, it must be modulated on to a carrier signal that is sufficiently stable with temperature.

Many factors allow detection by a tuned receiver in the presence of interference. The two most important factors affecting the design of a carrier frequency source are: *Frequency Stability* and *Phase Noise*.

The stability of the oscillator with temperature determines the channel spacing required to contain the modulated carrier signal. Conversely, for a given regulated channel spacing, the frequency stability determines the maximum data rate that can be supported without violating the channel boundary.

The oscillator phase noise results in a broadband component to the carrier signal which will extend into adjacent channels. If the phase noise is too high, this can corrupt the modulation source itself, and limit adjacent channel selectivity due to reciprocal mixing, as shown in Figure (2.4).

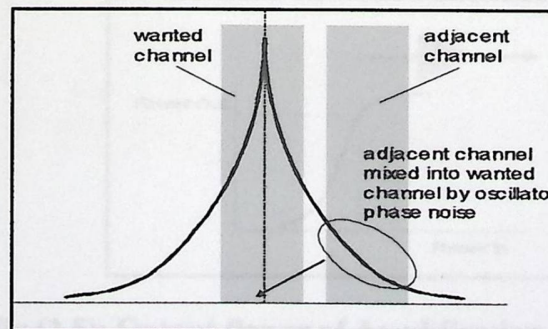


Fig (2.4): Reciprocal Mixing with Non-Ideal Oscillator

- **Modulation:**

The method of imposing the information signal onto the carrier signal is termed *modulation* which can be AM modulation or FM modulation and must be accomplished cost effectively and accurately for maximum range and minimum interference.

Amplitude modulation (AM) is a method of impressing data onto an alternating-voltage (*AC*) *carrier waveform*. The highest *frequency* of the modulating data is normally less than 10 percent of the carrier frequency. The instantaneous amplitude varies depending on the instantaneous amplitude of the modulating data.

- **Amplification:**

The amplifier is a key part of the transceiver, and must be efficient which means low cost and possibly linear. Output power is dictated by regulation, range requirement, cost and linearity considerations, as shown in Figure (2.5).

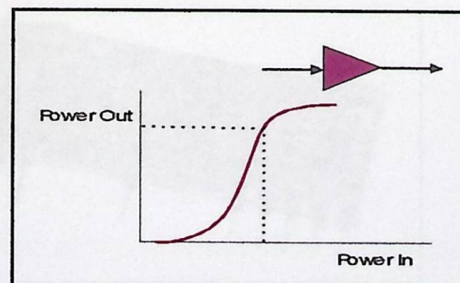


Fig (2.5): Output Power of Amplification

- **Antenna:**

The antenna is often the most poorly engineered part of a communication system. Good design will ensure maximum range, high amplifier efficiency (good matching), good selectivity, minimal pollution, good interference rejection, good sensitivity.

2.4.2 RR3-XXX Receiver

Because of the wireless system, it is needed to transmit the signals from the door to the receiver module, which is designed such that it can handle the messages from transmitter.^[8]

Here we used the RR3-XXX receiver, which is compatible with the used transmitter.

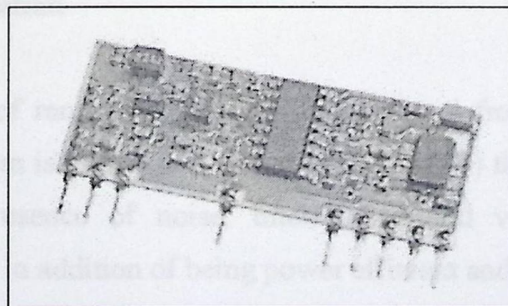


Fig. (2.6): RR3-433.92 Receiver

The levels of receiving process are presented in Figure (2.7).

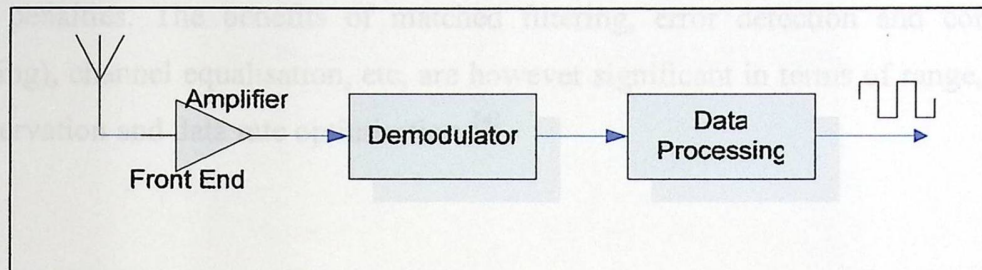


Fig (2.7): Basic Block for Receiver

- **Reception**

Key to the sensitivity is the receiver 'front end'. The main task is to boost weak wanted signals, often in the presence of strong unwanted signals which introduce minimal noise and distortion. In many cases, some selective filtering is required to assist this task.

- **Demodulation**

The process of removing the information signal from the carrier is termed *demodulation*. The aim is to design a circuit (or algorithm) that will achieve this task optimally in the presence of noise, interference and varying signal strength, frequency and phase, in addition of being power efficient and cheap.

- **Data Processing**

Pre and post processing of the information signal is often implying some form of micro process with the presumed complexity, cost, power consumption and size penalties. The benefits of matched filtering, error detection and correction (coding), channel equalisation, etc, are however significant in terms of range, power conservation and data rate optimisation. [4]

2.4.3 PIC Microcontrollers

A microcontroller is a high integrated chip which includes, on one chip, all or most of the parts needed for a controller. The microcontroller could be called a "one-chip solution."

PIC 16F84 Microcontroller

It is an 18-pin enhanced FLASH/EEPROM 8-Bit Microcontroller; see Figure (2.8).

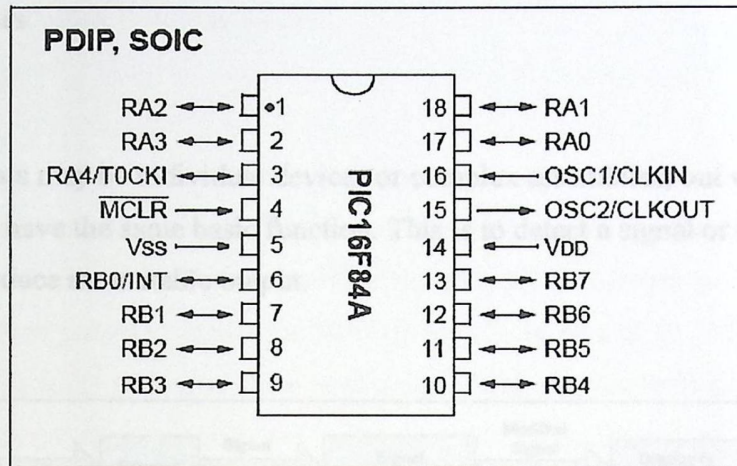


Fig. (2.8): PIC16F84 Pin Layout

PIC 16F84 Features:

- Only 35 single word instructions to learn.
- 1024 words of program memory.
- 68 bytes of Data RAM.
- 64 bytes of Data EEPROM.
- 15 Special Function Hardware registers.
- Eight-level deep hardware stack.
- Direct, indirect and relative addressing modes.
- 13 I/O pins with individual direction control.
- High current sink/source for direct LED drive.

2.4.4 Sensors

Sensors may be individual devices or complex assemblies, but whatever their form they all have the same basic function. This is to detect a signal or stimulus and from this produce measurable output.

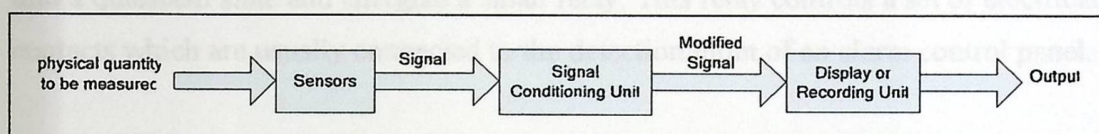


Fig. (2.9): Functional Elements of Measurement

Sensors detect various physical parameters, but it is what we do with this information that makes sensors useful. In general there are two distinct areas where sensors technology is used:

- Gathering information.
- Controlling systems.

Sensors used to gather information; provide data for display purpose to give an understanding of the status of system parameters. Sensors used to control systems are not differentiated than those used for information gathering. It is what is done with information from the sensor is different. In a control system, the signal from the sensor is an input to a controller. In this system, there is a need for sensors to sense different variables or things and then return information or data to the user. To complete the objective of our project we use different sensors.

2.4.4.1 PIR Motion Detector Sensor

Passive infrared sensors are electronic devices that measure infrared light radiating from objects in the field of view. The PIR device can be thought of as a kind of infrared 'camera' which remembers the amount of infrared energy focused on its surface. Once power is applied to the PIR the electronics in the PIR shortly settle into a quiescent state and energize a small relay. This relay controls a set of electrical contacts which are usually connected to the detection input of an alarm control panel.

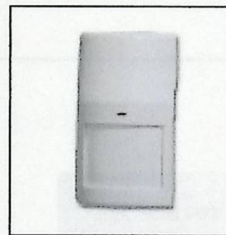


Fig. (2.10): PIR Motion Detector Sensor

A few mechanisms have been used to focus the distant infrared energy onto the sensor surface. The window may have Fresnel lenses moulded into it. Alternatively, sometimes PIR sensors are used with plastic segmented parabolic mirrors to focus the infrared energy, when mirrors are used, the plastic window cover has no Fresnel lenses moulded into it, see Figure (2.11).

The human body radiates infrared waves with wavelengths of 8 to 12 micrometers. Any movement by a person leads to a change in the amount of infrared energy which a sensor can detect within its range. If the amount of infrared energy

focused on the sensor changes within a configured time period, the device will switch the state of the alarm output relay. The alarm output relay is typically a "normally closed (NC)" relay, also known as a "Form B" relay.

Applications

Security systems, intrusion detection, automatic doors motion triggered events such as remote animal photography

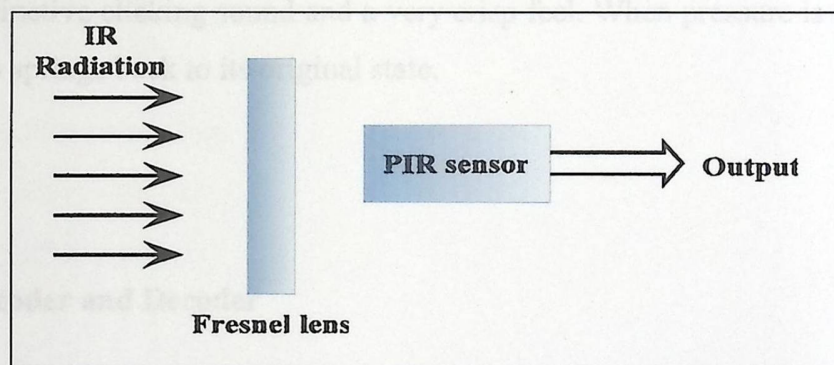


Fig. (2.11) Conventional PIR Detector

2.4.4.2 Bump Sensor

Bump sensor is a generic term of sensors used to refer to an electric switch that is designed to be actuated by the physical motion of mechanical devices and is

generally packaged in a small form factor to allow placement in small spaces, see Figure (2.12).

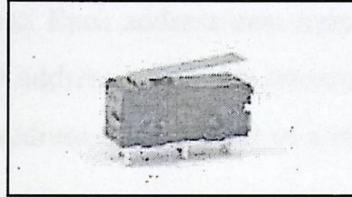


Fig. (2.12): Bump Sensor

Internally a stiff metal strip must be bent to activate the switch. This produces a very distinctive clicking sound and a very crisp feel. When pressure is removed the metal strip springs back to its original state.

2.4.5 Encoder and Decoder

- **HT12E Encoder**

An encoder is a device used to change a signal (such as a bit stream) or data into a code. The code may serve any of a number of purposes such as compressing information for transmission or storage, encrypting or adding redundancies to the input code, or translating from one code to another. This is usually done by means of a programmed algorithm, especially if any part is digital, while most analog encoding is done with analog circuitry.^[6]

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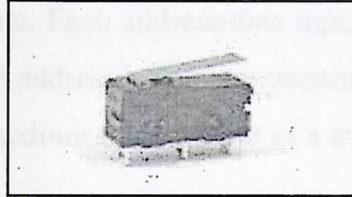


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The HT12E encoder is a CMOS LSI for remote control system applications. It will interface to RF transmitter modules to create a secure single or multiple channel RF remote control transmitters. The oscillator is configured simply with the addition of a resistor. It is capable of encoding information, which consists of N address bits and 12-N data bits. Each address/data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF transmission medium upon receipt of a trigger signal.

Applications:

- Burglar alarm system.
- Smoke and fire alarm system.
- Garage door controllers.
- Car door controllers.
- Car alarm system.
- Security system.

- **HT12D Decoder:**

A decoder is a device used to in digital electronics this would mean that a decoder is a multiple-input, multiple-output logic circuit that converts coded inputs into coded outputs, where the input and output codes are different. e.g. n-to- 2^n , BCD decoders.^[7]

The HT12D decoder is a CMOS LSI for remote control system applications. It will interface to RF receiver modules to create a secure single or multiple channel RF remote control receiver. The decoder receives serial addresses and data from a programmed encoder that are transmitted by a carrier using an RF or an IR transmission medium. The decoder compares the serial input data three times continuously with its local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission. The HT12D decoder is capable of decoding information that consist of N bits of address and 12-N bits of data. The HT12D is arranged to provide 8 address bits and 4 data bits.

Applications:

- Smoke and fire alarm system.
- Garage door controllers.
- Car door controllers.
- Car alarm system.

2.4.6 PC Parallel Port

The Parallel Port is known as the printer port, which is the most commonly used port for interfacing computers with homemade projects. This port allows the input of up to 9 bits or the output of 12 bits at any given time, thus requiring minimal external circuitry to implement many simpler tasks.

The parallel port, as implemented on the PC, consists of a connector with 17 signal lines and 8 ground lines. The signal lines are divided into three groups: 4 Control lines, 5 Status lines, and 8 Data lines.

As originally, designed, the Control lines are used as interface control and handshaking signals from the PC to the printer. The Status lines are used for handshake signals and as status indicators for such things as paper empty, busy indication and interface or peripheral errors. The data lines are used to provide data from the PC to the printer, in that direction only. Later implementations of the parallel port allowed for data to be driven from the peripheral to the PC. Figure (2.13) shows the parallel port pins.

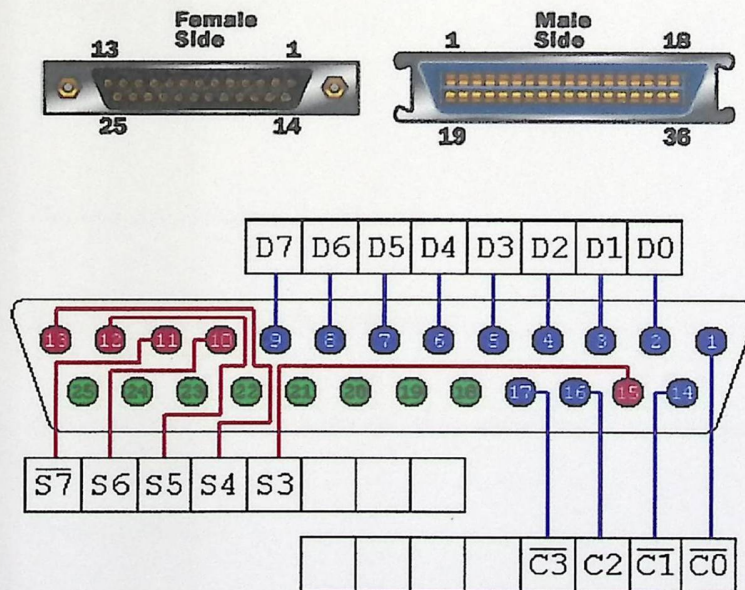


Fig. (2.13): Parallel Port Pins

Accessing the parallel port differs between programming languages for example in Ansi C, there is some built in functions, which are used for reading from, and writing to the port. In Java there are not such as functions so we will need to use JNI (Java Native Interface) and use native methods to communicate with the port. The native methods will load a dynamic link library file named jnpout32reg.dll, which have function calls to access the parallel port.

Chapter

3

Project Conceptual Design

3.1 Project Objectives.

3.2 Design Options.

3.3 Design Realization Approach.

3.4 Project Design Block Diagrams.

3.5 Project Interacting with the Surrounding Environment.

3.6 System Models.

Chapter

3

Project Conceptual Design

3.1 Project Objectives.

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3.6 System Models.

Chapter Three

Project Conceptual Design

In this chapter, we are going to describe the detailed objectives of the system, the general block diagram and explain how the system works.

3.1 Project Objectives

This project supports many ideas and objectives that can be summarized as follows:

- To design and implement a security system that is able to sense any person come close to the door and tries to open it.
- To design a security system in such a way that it protects small residential areas like the small departments or rooms.
- To design a security system that is very precise and sensitive while also being cost effective.
- To add an element of security to places where you don't want anybody to enter or even come close to it.

- To use a wireless technology that gives the time to detect any try of intrusion before occurred.

3.2 Design Options

This section elaborates on the justifications of use the sensors the wireless RF for transmitting.

Unlike the infrared, RF was used to transmit data since it does not need line of sight, not blocked by common materials, and not light sensitive. It is also provides longer range and it is not as sensitive to weather environmental conditions. Data transfer speed of RF is faster than Bluetooth technology, where the speed in transferring is a very important factor in the security system to get faster response for any try of intrusion.

Regarding the sensor issue, at the beginning of the semester we started to work on the capacitance sensor by building its circuit, a non-inverting op-amp and a touch wire acts as the sensor input and is hocked to the doorknob were used. The inputs of the op-amp are grounded so that the capacitance difference can be sensed each time you touch the wire. This will be done in order to saturate the voltage levels to produce a digital high or digital low. Nevertheless, after many testing levels we realized the useless of using this sensor and started to search for alternative.

The use of bump sensor rather than constructing the circuit of the capacitance sensor has come because of many reasons: accuracy, and cost. Any one can wear gloves and then no voltage saturation would be occurred so it would be considered as a weak point in our design for the project. Furthermore, buying the sensor is more cost effective than building it.

3.3 Design Realization Approach

One of the most complicated parts to decide on is how to apply our idea of project on the real world, many approaches are used, implementation, modeling, or simulation.

Fortunately, all the needed chips were available with a reasonable price so there were no problems to get them and to start the hardware implementation.

3.4 Project Design Block Diagrams

The following Figure shows the block diagrams of our system. It consists of several units are accomplished and integrated to form the final wireless security system, these units are:

- **Detection Unit:** which is connected to the door and contains different sensors to detect a doorknob touching or movement of the person.
- **Transmitter Unit:** this contains a PIC microcontroller and a wireless transmitter.
- **Receiver Unit:** which contains a RF receiver, it connected to the computer through parallel port

Figure (3.1) describes the general block diagram of the transmitting Unit.

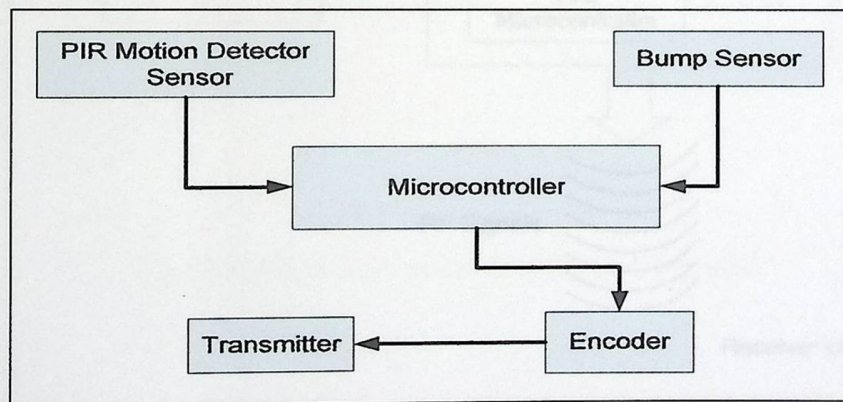


Fig. (3.1): Transmitting Module Block Diagram

The general block diagram of the Receiving Unit is presented I Figure (3.2). In addition, the general block diagram of the whole system is shown in Figure (3.3).

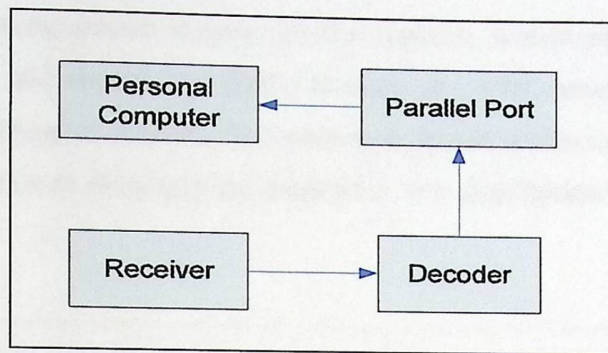


Fig. (3.2): Receiving Module Block Diagram

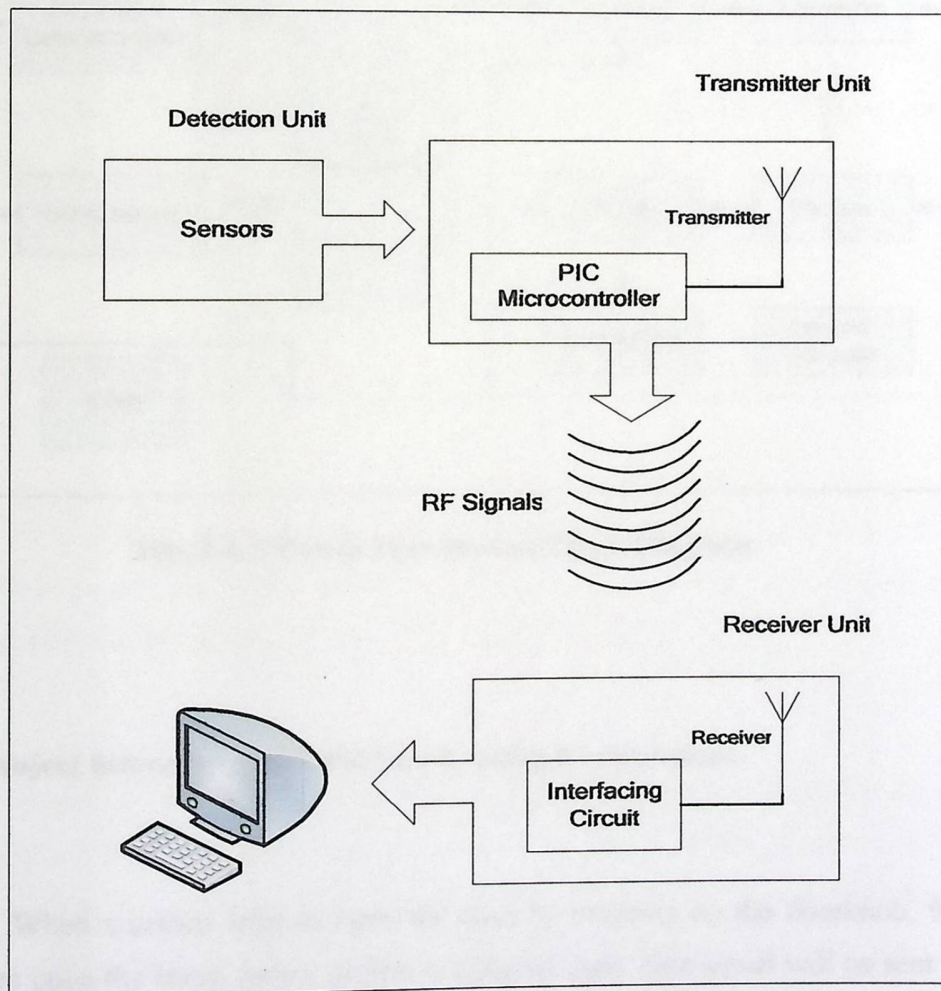


Fig. (3.3): General Block Diagram

In the system, power supply for the sensors, microcontroller, transmitter, receiver, decoder, and encoder is needed. Battery of 5 VDC power supply is used to supply a stable voltage to a circuit that must be operated within certain power supply limitations; Figure (3.4) illustrates the detailed power distribution for the system.

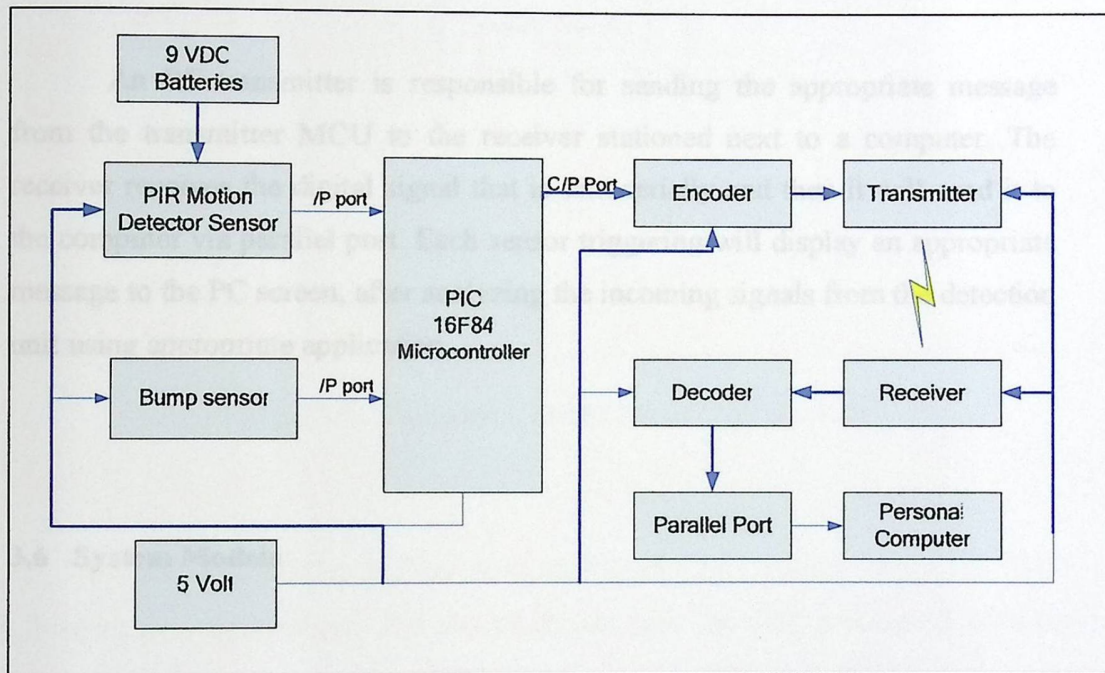


Fig.(3.4) : Power Distribution Block Diagram

3.5 Project Interacting with the Surrounding Environment

When a person tries to open the door by pressing on the doorknob, the pressure upon the bump sensor produces a digital high. This signal will be sent to the MCU on the transmitter unit. The same happens when someone comes close

to the door; the PIR sensor will send a signal to the MCU on the transmitter. Since its working principle is any movement by a person leads to a change for energy that a sensor can detect within its range. Thus, the MCU on the transmitter is programmed so that it can handle the two different sensors triggering appropriately.

An RF transmitter is responsible for sending the appropriate message from the transmitter MCU to the receiver stationed next to a computer. The receiver receives the digital signal that is sent serially and then it will send it to the computer via parallel port. Each sensor triggering will display an appropriate message to the PC screen, after analyzing the incoming signals from the detection unit using appropriate application.

Fig. (3.5) Sequence Diagram of Our System

3.6 System Models

is illustrated in Figure (3.6) which shows the steps involved in the transmitting. The model shows how the data associated with the transmitter process moves through the system. Also, Figure (3.7) shows the data

This section introduces a number of different types of system models. These models are graphical representations that describe the system. Models are often more understandable than detailed natural language.

Figure (3.5) describes the sequence diagram with objects along the top of the diagram. Basic operations are indicated by arrows. In this scenario, if the intruder holds the doorknob, bump sensor signal will be sent. On the other hand, if the motion sensor detects any movement within its range, another signal is sent. Also the microcontroller has the ability of distinguishing between the two signals.

Fig. (3.6) Data Flow Diagram of Transmitting Process

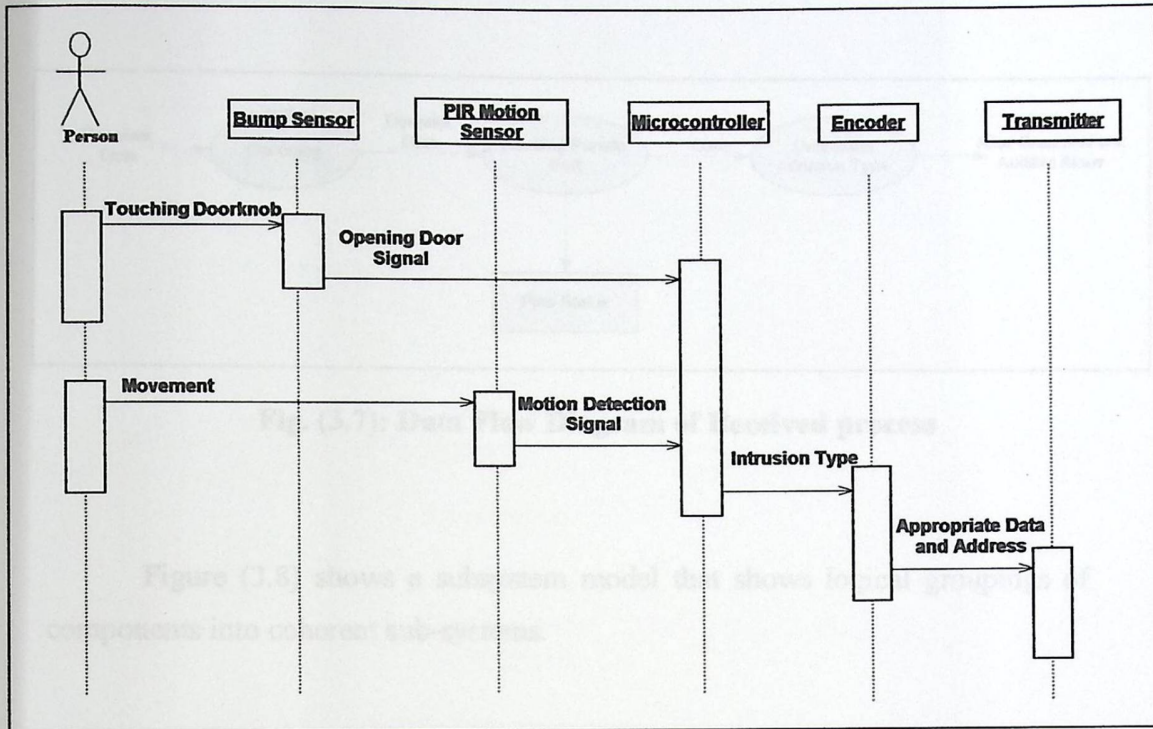


Fig. (3.5): Sequence Diagram of Our System

A data flow model is illustrated in Figure (3.6) which shows the steps involved in the transmitting. The model shows how the data associated with the transmitting process moves through the system. Also, Figure (3.7) shows the data flow model of the receiving process.

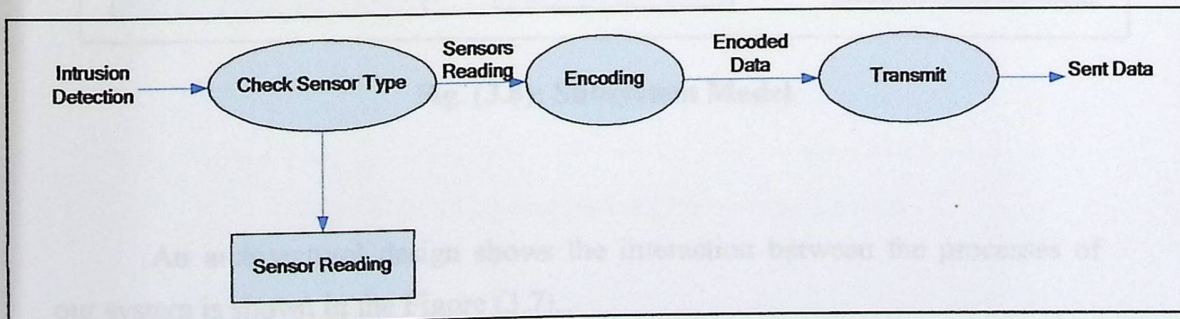


Fig. (3.6): Data Flow Diagram of Transmitting Process

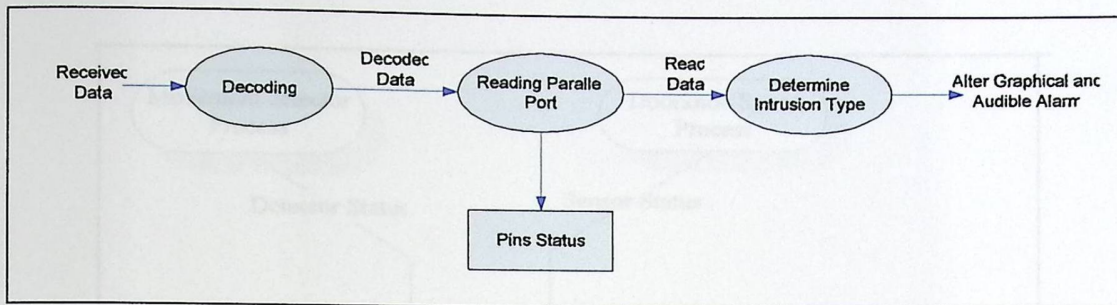


Fig. (3.7): Data Flow Diagram of Received process

Figure (3.8) shows a subsystem model that shows logical groupings of components into coherent sub-systems.

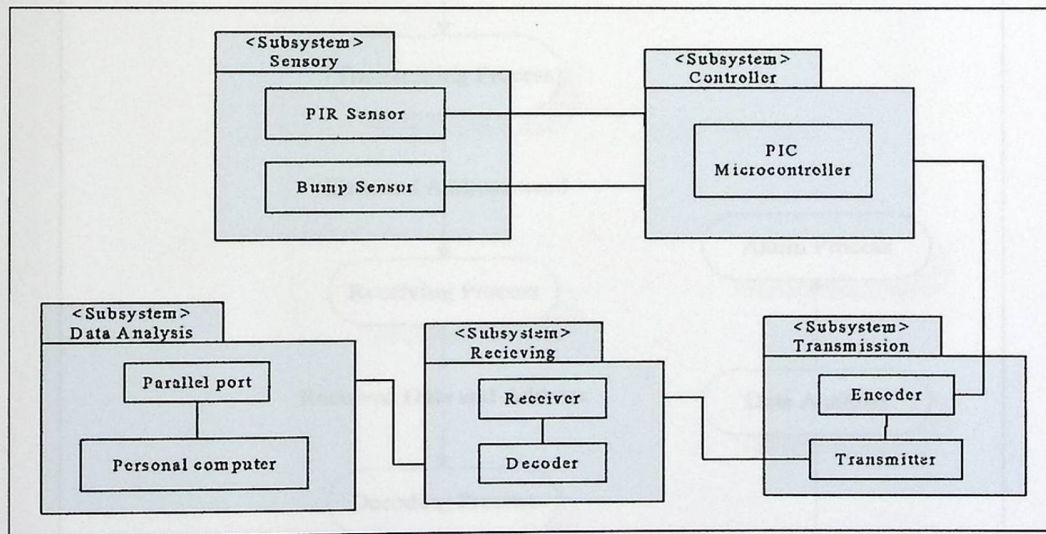


Fig. (3.8): Subsystem Model

An architectural design shows the interaction between the processes of our system is shown in the Figure (3.7).

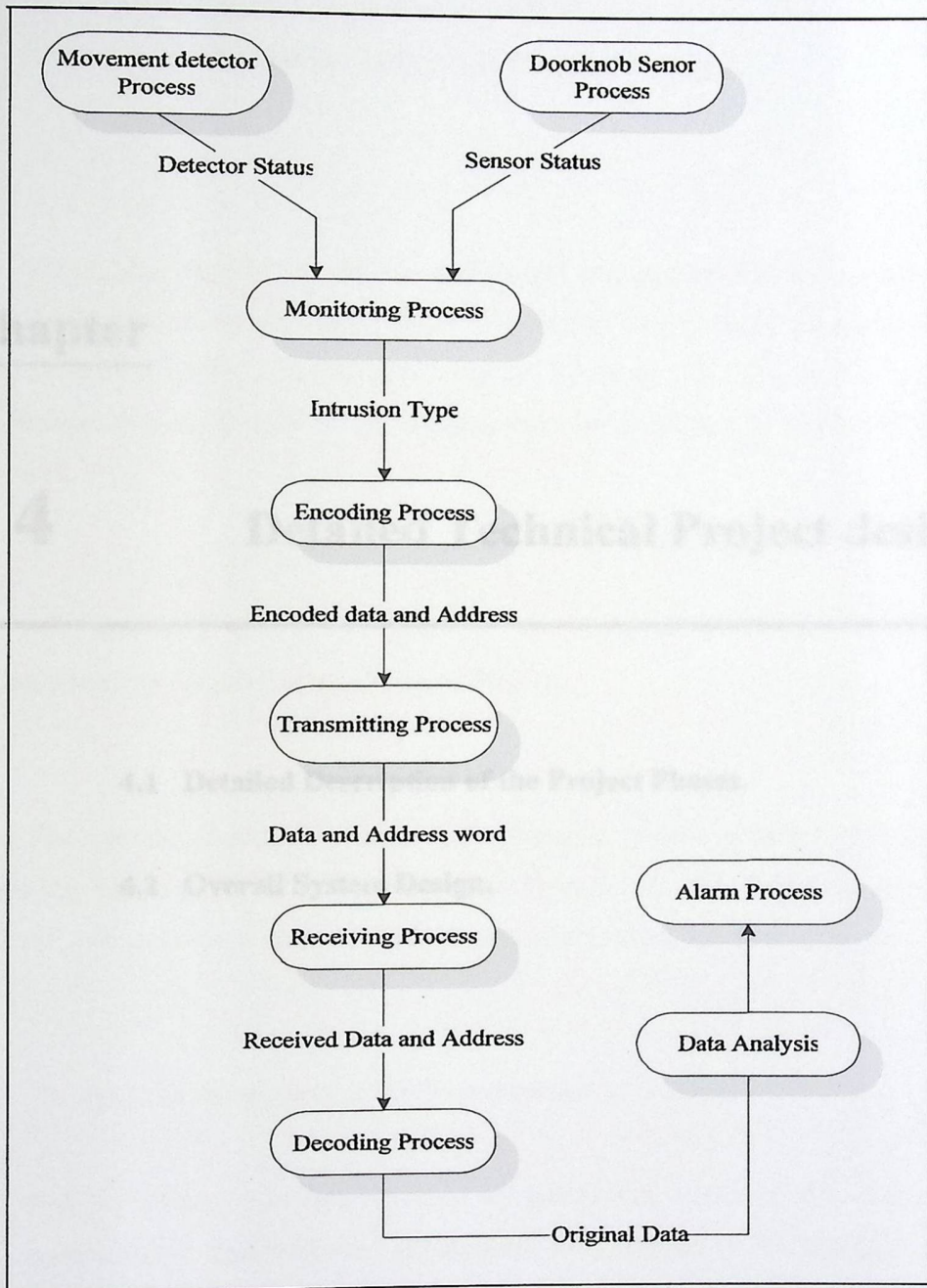


Fig. (3.9): Process Architecture of the System



Chapter Four Detailed Technical Project Design

After explaining the theoretical background, the general block diagram of the system works, there is a need to view what is the design of this system in more specific, powerful and more formal terms. This chapter describes the detailed system design with all its features that are necessary to make the system works well.

Chapter

4

Detailed Technical Project design

4.1 Detailed Description of the Project Phases.

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The system chosen for our wireless security system is based on amplitude modulation. The foundations for this technology are associated with two main circuit boards, transmitting board and receiving one.

4.2 Overall System Design.

The detailed description of the project phases is follows.

- Sensory phase: two sensors used to gather the status of the surrounding environment. The first one will be used to detect the movement of a person when he comes close to the door. The second one will be hold on the doorknob and trigger a high voltage whenever any try of opening the door.

Chapter Four

Detailed Technical Project Design

After explaining the theoretical background, the general block diagram of the system, and how the system works, there is a need to view what is the design of this system in more specific, powerful and more formal terms. This chapter describes the detailed system design with all its features that are necessary to make the system works well.

4.1 Detailed Description of the Project Phases.

The system chosen for our wireless security system is based on amplitude modulation (AM) and RF principles. The foundations for this technology are associated with two main circuit boards, transmitting board and receiving one.

The detailed description of the project phases as follows:

- Sensory phase: two sensors used to gather the status of the surrounding environment. The first one will be used to detect the movement of a person when he comes close to the door. The second one will be hold on the doorknob and trigger a high voltage whenever any try of opening the door.

- Processing phase: a PIC microcontroller is used to continuously check the status of the two sensors. Then, based on that it will produce the appropriate code to be sent, so it's needed to combine signals from various sensors.
- Transmitting phase:
 1. Whenever the transmission-enable signal is applied, the encoder (HT12E) scans and transmits the status of the 12 bits of address. If the trigger signal is not applied, the chip enters the standby mode and consumes a reduced current of less than 1mA.
 2. The RT4-433.92MHz transmitter uses the AM modulation to send signals serially.
- Receiving phase:
 1. The RR3-433.92MHz serial data receiver will demodulate the carrier and gives the address and data to the decoder HT12D.
 2. The decoder HT12D first compares the address three times and if it matches it gives high pulse on pin VT and then latches the data.
 3. The latched data will be sent through the parallel port to the computer, the interface between them via Inpout32.dll which is a dynamic link library that is used to easily control the operation of the parallel port of windows computer.

4.2 Overall System Design:

In this section the schematics, characteristics, features, and the specifications of each component and subsystem will be presented.

4.2.1 Transmitting Subsystem:

Figure (4.1) shows the schematic diagram of the transmitting subsystem, which is constructed of the encoder and the RF transmitter.

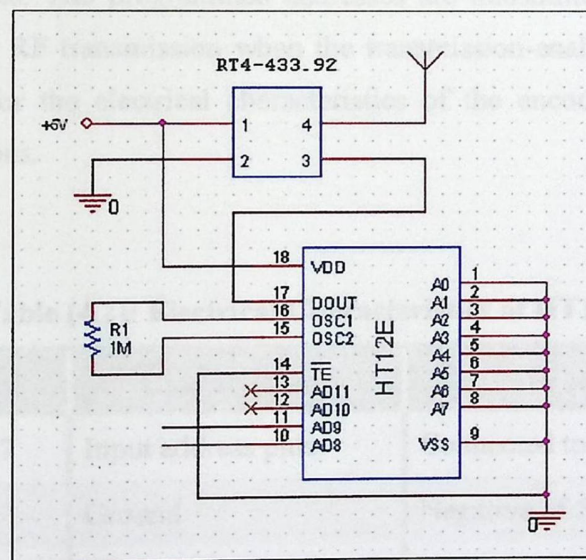


Fig. (4.1): Schematic Diagram of Transmitting Unit

The pin connections of the transmitter according to our project requirements are listed in the Table (4.1).

Table (4.1): Electrical Characteristics of RT4-XXX

Pin	Symbol	Characteristic	Specification
1	Vcc	Supply Voltage	Positive of 5V power supply
2	GND	Ground	Negative of 5V power supply
3	IN	Modulation Input	Connected to pin 17 of the encoder
4	EA	External Antenna	Connected to the Antenna

The encoder HT12E is a Low power and high noise immunity chip with Low standby current $1\mu\text{A}$ at 5V providing. It is capable of encoding information, which consists of N address bits and 12-N data bits. Each address input can be set to one of the two logic states. The programmed addresses are transmitted together with the header bits via an RF transmission when the transmission-enable signal is applied. See Table (4.2) for the electrical characteristics of the encoder according to the project specifications.

Table (4.2): Electrical Characteristics of HT12E

Pin(s)	Symbol	Characteristic	Specification
1-8	A0~A7	Input address pins	Connected to the ground
9	Vss	Ground	Negative of 5V power supply
10-13	AD8~AD11	Input address/data pins	Two pins connected to the PIC
14	TE	Transmission enable	Connected to the ground
15-16	OSC1~OSC2	Oscillator	Connected to $1\text{M}\Omega$ resistor
17	DOUT	Data serial transmission	Connected to pin 3 of transmitter
18	Vdd	Operating voltage	Positive of 5V power supply

Eight pins of addresses are connected to ground. Moreover, a $1\text{M}\Omega$ resistance is connected between the oscillation pins to generate a frequency equals 3 KHz (see appendix A).

4.2.2 Receiving Subsystem:

Figure (4.2) presents the schematic diagram of the receiving subsystem, which is constructed of the decoder and the RF receiver.

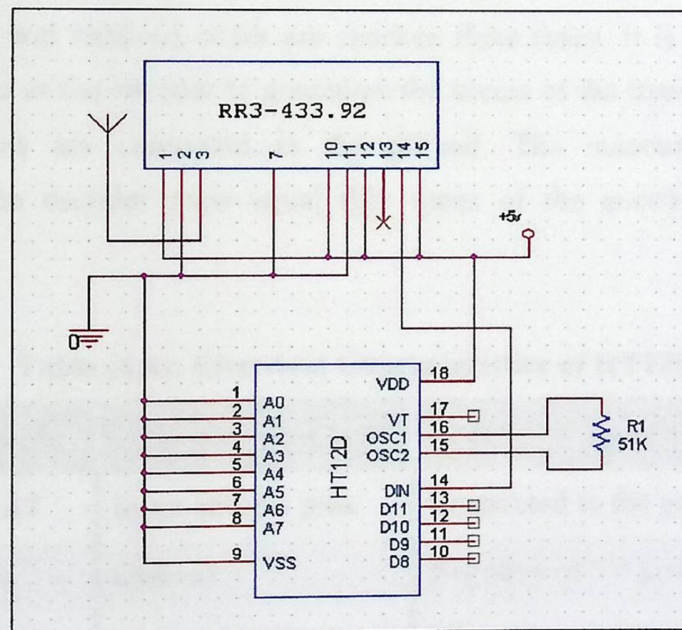


Fig. (4.2): Schematic Diagram of Receiving Unit

The pin connections of the receiver according to our project requirements are shown in the Table (4.3).

Table (4.3): Electrical Characteristics of RR3-XXX

Pin(s)	Symbol	Characteristic	Specification
1,10,12,15	Vcc	Supply Voltage	Positive of 5V power supply
2,7,11	GND	Ground	Negative of 5V power supply
3	IN	Antenna input	Connected to the Antenna
13	NC	Not connected	---
14	OUT	Output	Connected to the decoder

The encoder HT12D is low power and high noise immunity chip with low standby current and received codes are checked three times. It is necessary to have the same address as the encoder to guarantee the access of the transmitted data, so all the address pins are connected to the ground. The recommended oscillation frequency of the decoder must equal fifty times of the encoder frequency (see Appendix A).

Table (4.4): Electrical Characteristics of HT12D

Pin(s)	Symbol	Characteristic	Specification
1-8	A0~A7	Input address pins	Connected to the ground
9	Vss	Ground	Negative of 5V power supply
10-13	AD8~AD11	Output data pins	Two pins connected to the parallel port
14	DIN	Data input	Connected to the receiver
15-16	OSC1~OSC2	Oscillator	Connected to 51K Ω resistor
17	VT	Valid Transmission	—————
18	Vdd	Operating voltage	Positive of 5V power supply

4.2.3 Sensory Subsystem:

The diagram of the bump sensor is presented in Figure (4.3).

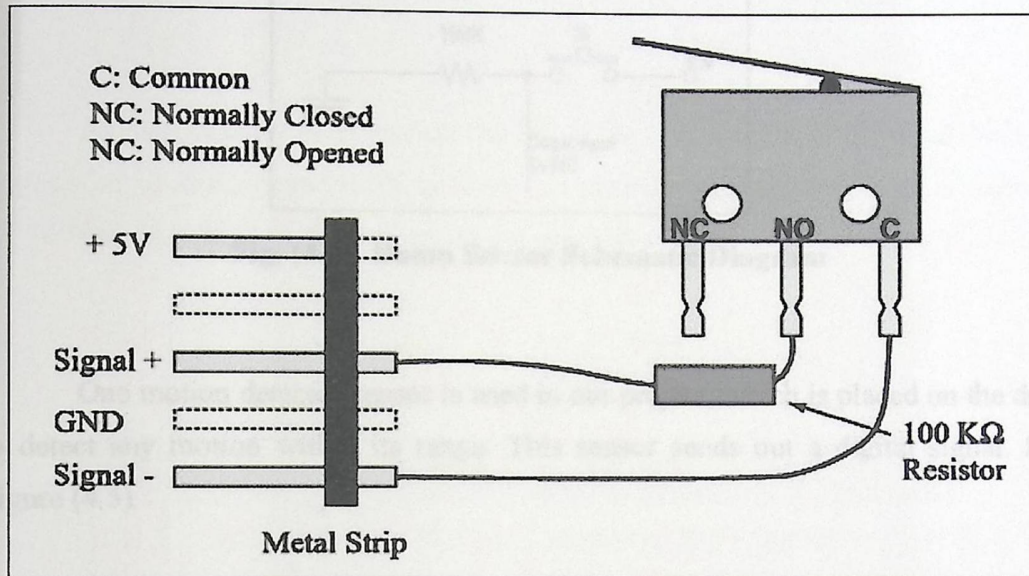


Fig. (4.3): Bump Sensor Diagram

The option of choosing micro switch sensor refers to

- No need for external circuit.
- Availability.
- Low cost.
- Small size.

This sensor is mounted on the doorknob. The switch normally keeps the microcontroller input pin at 0 volt until a pressure occurs, at that time, the switch hit

will close, bringing the output voltage up. Figure (4.4) shows the schematic diagram of the bump sensor.

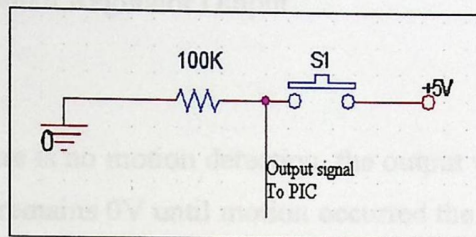


Fig. (4.4): Bump Sensor Schematic Diagram

One motion detector sensor is used in our project, which is placed on the door to detect any motion within its range. This sensor sends out a digital signal. See Figure (4.5)

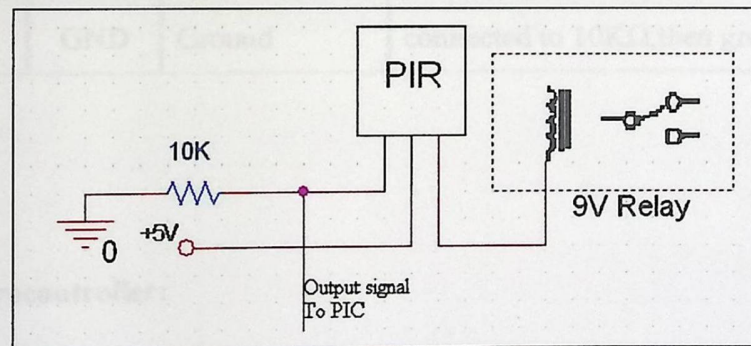


Fig. (4.5): PIR Sensor Schematic Diagram

Features:

- Power: 9V DC
- Working frequency: 315MHz

- Detector distance: 2 - 12m
- Detector angle: 90 degrees
- Working temperature: -5 - 50°C
- Optional 5V Shunt Regulator Output

As long as there is no motion detection, the output voltage measured from the terminal of a resistor remains 0V until motion occurred the output voltage is raised to 5V. Table (4.5) presents the Pin configuration of the PIR sensor.

Table (4.5): Pins Configuration PIR

Pin	Symbol	Characteristic	Specification
1	Vcc	Supply Voltage	connected to 9V battery
2	Vcc	Supply Voltage	Positive of 5V power supply
3	GND	Ground	connected to 10KΩ, then ground

4.2.4 Microcontroller:

Figure (4.6) describes the microcontroller schematic and shows how few components are needed to get the microcontroller up and running. Primarily it needs a pull-up resistor on pin 4, 4MHz crystal with two 22pF capacitors and 5V power supply. The pins configuration of the PIC according to the project specifications are listed in Table (4.6).

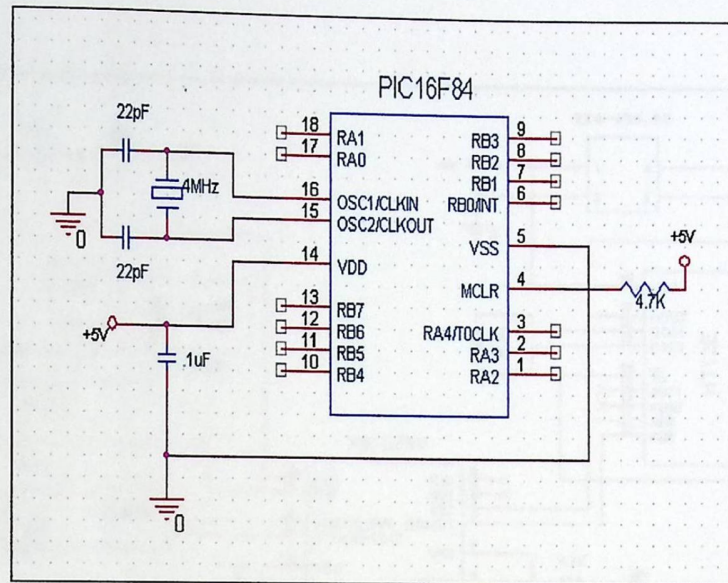


Fig. (4.6): PIC 16F84 Schematic Diagram

Table (4.6): Pins Configuration of the PIC

Specific Connection	PIC16F84 Pin	Pin Configuration
PIR motion Detection	RA0	Input
Bump Sensor	RA1	Input
Motion Detection	RB0	Output
Doorknob Detection	RB1	Output
External Oscillator	OSC1/OSC2	
Voltage Alimentation	VDD/VSS	Power
Reset Circuit	MCLR	

All the components of our project are integrated into two main boards, a transmitting and receiving, see Figure (4.7).

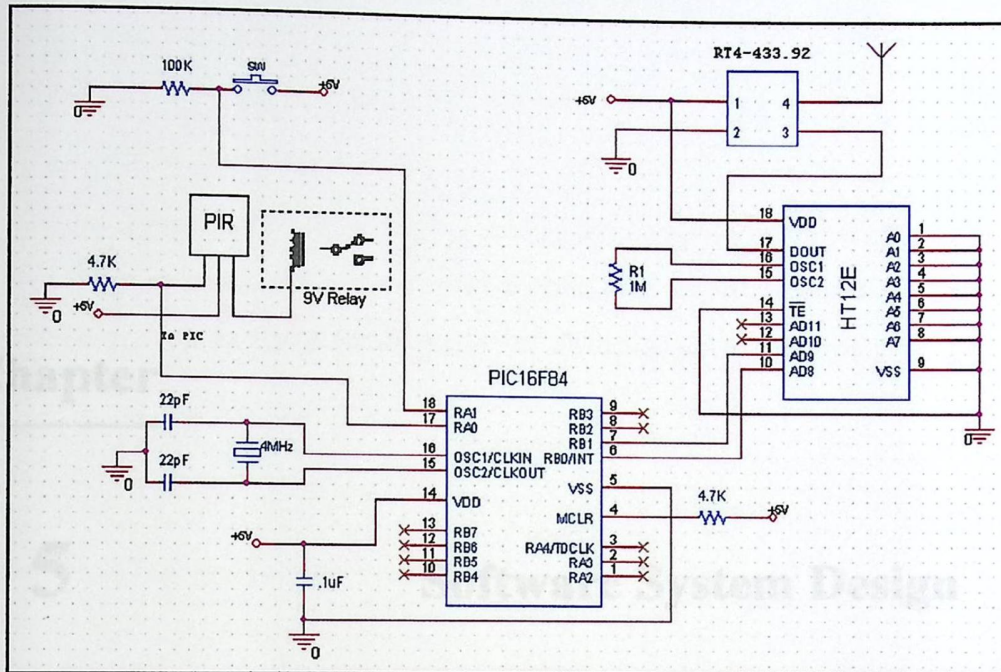


Fig. (4.7-a): Schematic Diagram of Transmitting Board

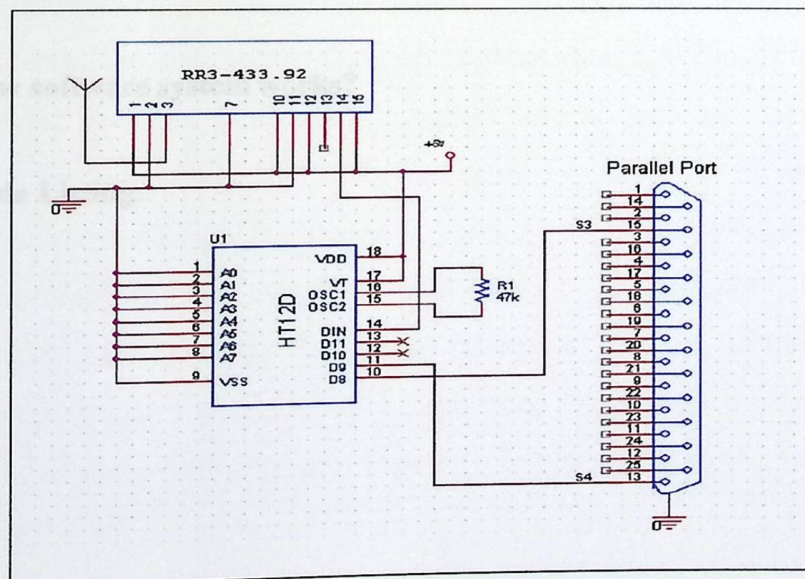


Fig. (4.7-b): Schematic Diagram of Receiver Board

Chapter Five Software System Design

This chapter talks about implementing the system from a programming point of view. This includes the general pseudocode, the algorithms used in the system, and flowcharts that explain the sequence of all the stages of the program.

Chapter

5

Software System Design

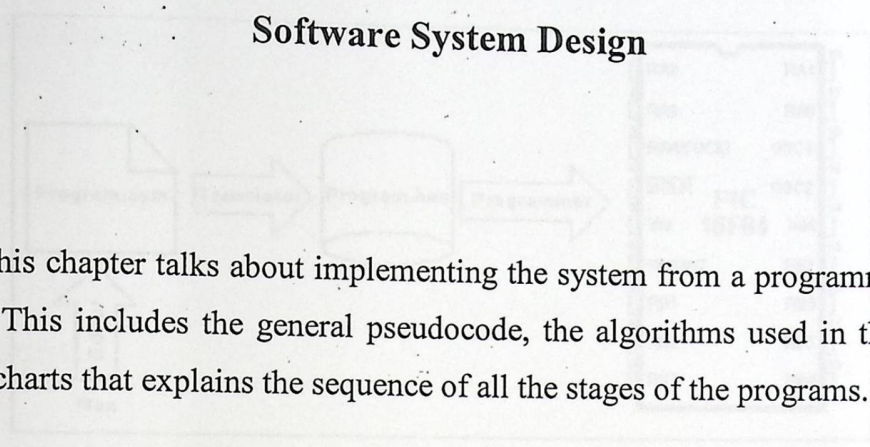
5.1 Software Needed for the Project.

5.2 How software system works?

5.3 Code Listing.

Chapter Five

Software System Design



This chapter talks about implementing the system from a programming point of view. This includes the general pseudocode, the algorithms used in the system, and flowcharts that explain the sequence of all the stages of the programs.

5.1 Software Needed for the Project

PIC programmer was used to program the PIC16F84. Programs written in assembly language must be translated into a "zeros and ones" in order for a microcontroller to understand it. "Assembly language" and "assembler" are two different notions. The first represents a set of rules used in writing a program for a microcontroller, and the other is a program on the personal computer which translates assembly language into zeros and ones. Physically, program represents a file on the computer disc (or in the memory if it is read in a microcontroller), and is written according to the rules of assembler or some other language for microcontroller programming. Translator interprets each instruction written in assembly language as a series of zeros and ones which have a meaning for the internal logic of the microcontroller. Figure (5.1) represents all the basic phases of programming the PIC.

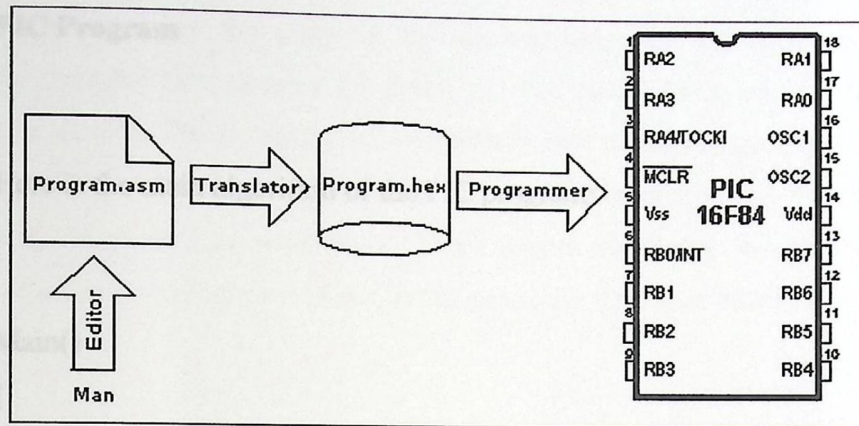


Fig. (5.1): PIC Programming Phases

JAVA programming language has been used to implement the interfacing with the parallel port. Different programming languages can access the parallel port. Ansi C is a programming language with built in function, which are used for reading from, and writing to the port. On the other hand, there are not such as functions in JAVA. So it is needed to use JNI (Java Native Interface) and use native methods to communicate with the port. The native methods will load a dynamic link library file named jnpout32reg.dll, which have function calls to access the parallel port.

5.2 How System Software Works?

In this section, flowcharts will be introduced to describe the programs of both the PIC, and the application on the computer side. Flowcharting is a tool for analyzing processes.

5.2.1 PIC Program

The program by placing loops in the code so they are repeatedly executed thus causing the delay. All PIC instructions are executed in one machine cycle with the exception of instructions that cause the program counter to change. Here is the main algorithm of the PIC program:

Each machine cycle takes 1µs with the 4 MHz crystal oscillator. By calculating the number of machine cycles carried out in the execution of one or more loops.

```
Main()
```

```
{
```

```
    while (true)
```

```
    {
```

```
        if (PortA.A0)
```

```
            PortB.B0=1;
```

```
        else
```

```
            PortB.B1=0;
```

```
        if (PortA.A1)
```

```
            PortB.B1=1;
```

```
        else
```

```
            PortB.B1=0;
```

```
        Delay();
```

```
    }
```

```
}
```

Here we delay the program by placing loops in the code so they are repeatedly executed thus causing the delay. All PIC instructions are executed in one machine cycle with the exception of instructions that cause the program counter to change, such as GOTO, which require two machine cycles to complete. Each machine cycle takes $1\mu\text{s}$ with the 4 MHz crystal oscillator. By calculating the number of machine cycles carried out in the execution of one or more loops.

The following flowchart, Figure (5.2), describes how the program should work to meet the hardware specifications. The program is basically designed in such a way that it continuously checks the status of the two pins of input port. Depending on their status, the program should control the output of two pins of the output port.

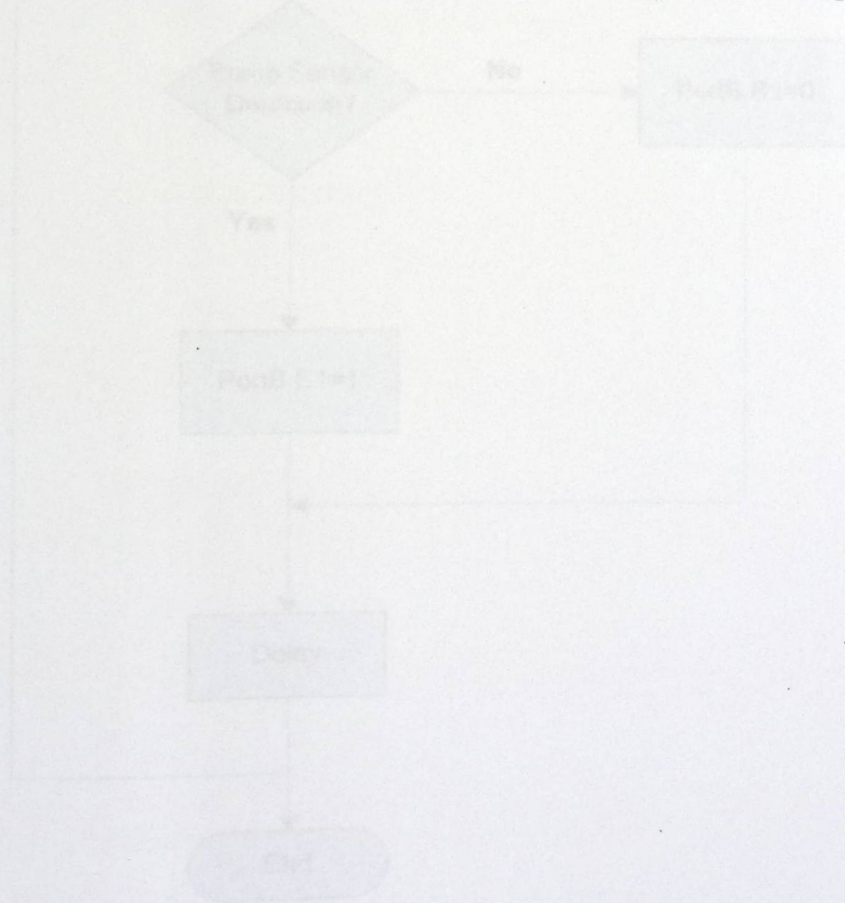


Fig. (5.2): General Flowchart for PIC Program

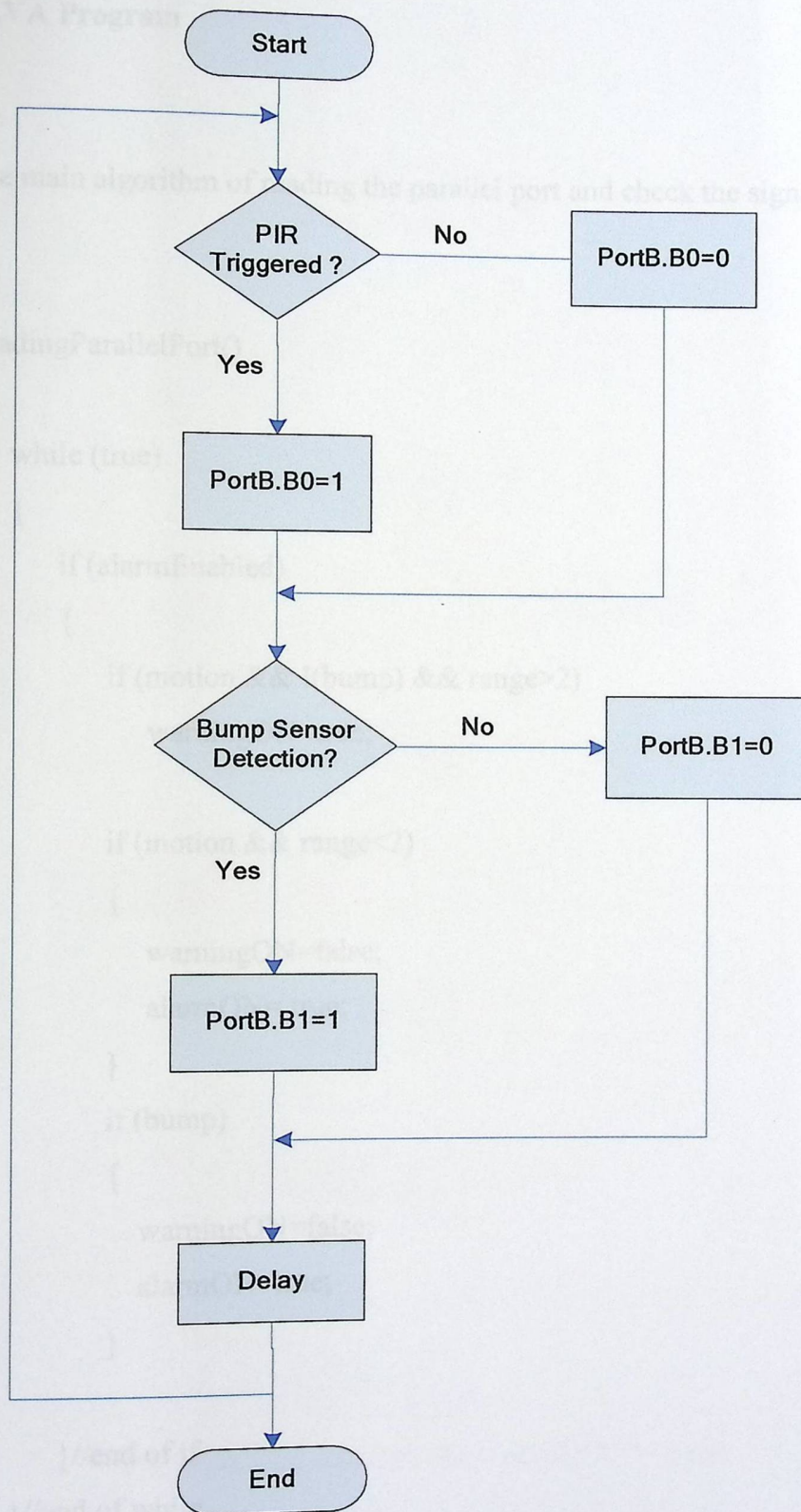


Fig. (5.2): General Flowchart for PIC Program

5.2.2 JAVA Program

The main algorithm of reading the parallel port and check the signal, as follows:

```
ReadingParallelPort()
{
    while (true)
    {
        if (alarmEnabled)
        {
            if (motion && !(bump) && range>2)
                warningON=true;

            if (motion && range<2)
            {
                warningON=false;
                alarmON= true;
            }
            if (bump)
            {
                warningON=false;
                alarmON=true;
            }
        }

        }//end of if
    }//end of while
}
```

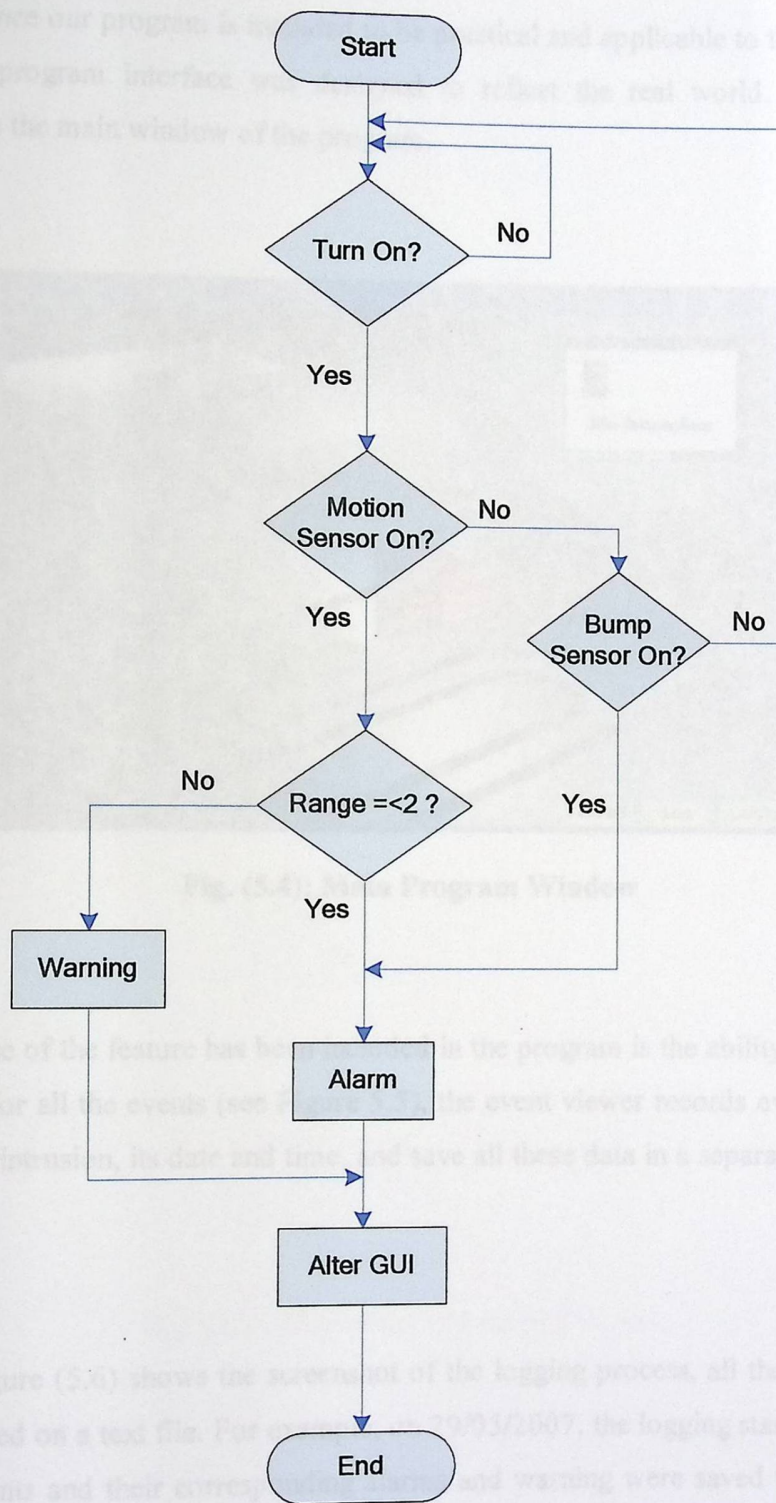


Fig. (5.3): General Flowchart of JAVA Program

Since our program is intended to be practical and applicable to the day-to-day use, the program interface was designed to reflect the real world. Figure (5.4) represents the main window of the program.

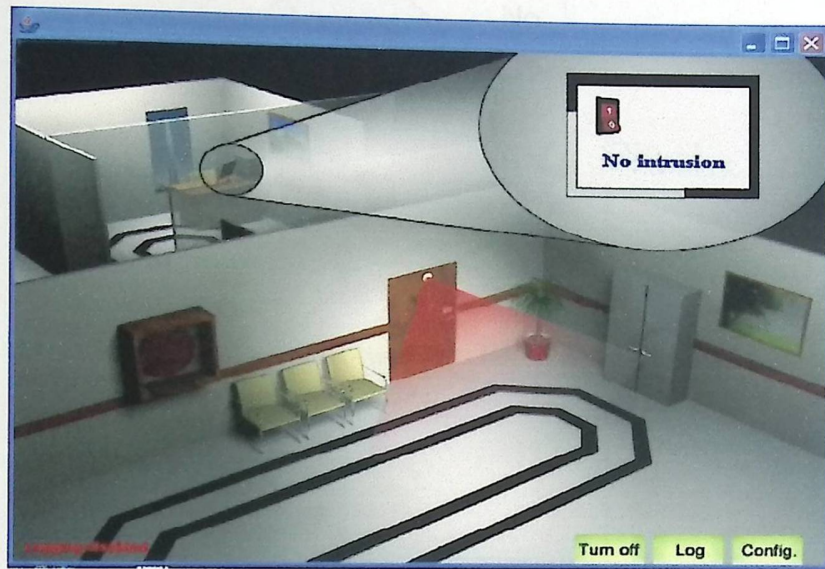


Fig. (5.4): Main Program Window

One of the features has been included in the program is the ability to provide a schedule for all the events (see Figure 5.5), the event viewer records every intrusion or trial of intrusion, its date and time, and save all these data in a separated file in the computer.

Fig. (5.5): Flowchart of Logging Process

Figure (5.6) shows the screenshot of the logging process, all the transactions are recorded on a text file. For example, on 29/05/2007, the logging started at 13:41, all the events and their corresponding alarms and warning were saved to keep track on all the transactions occurred on that day.

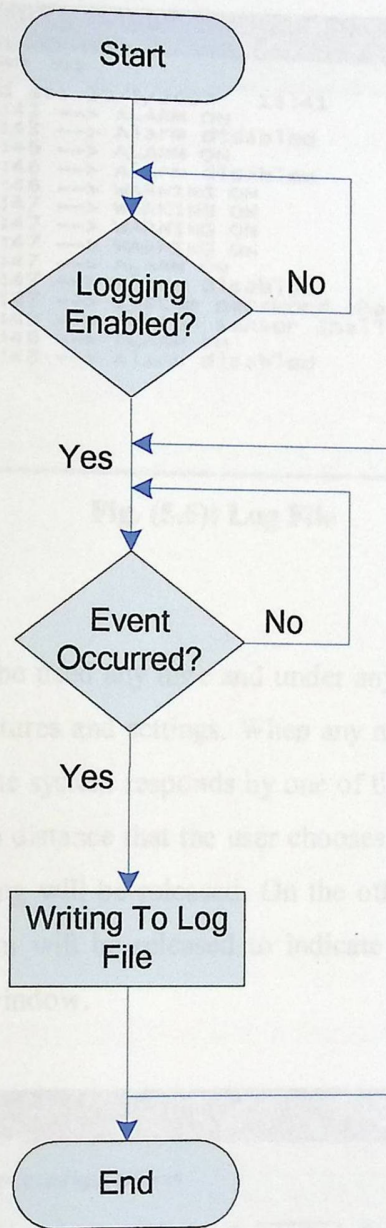


Fig. (5.5): Flowchart of Logging Process

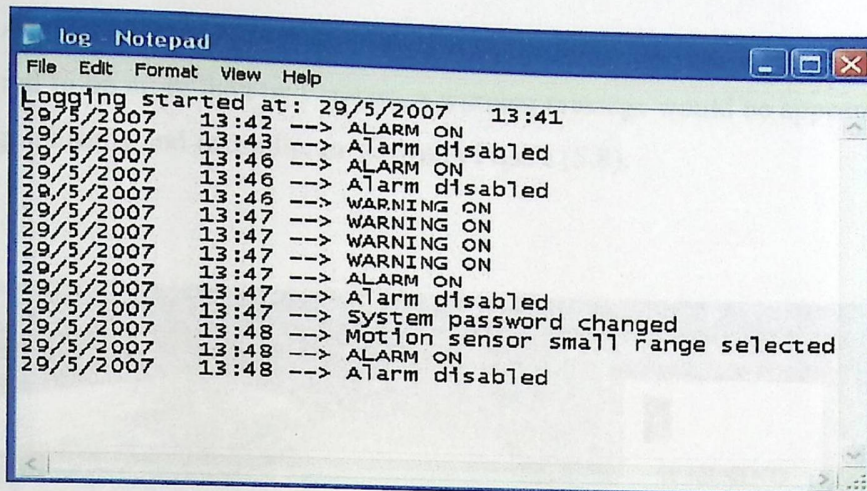


Fig. (5.6): Log File

The program can be used any time and under any conditions, that is, user can configure most of the features and settings. When any movement is detected by PIR motion detector sensor, the system responds by one of the two ways according to the configuration of detection distance that the user chooses. If the chosen range is more than two meters, a warning will be released. On the other hand, if the range is less than two meters, an alarm will be released to indicate more danger. Figure (5.7) shows the configuration window.

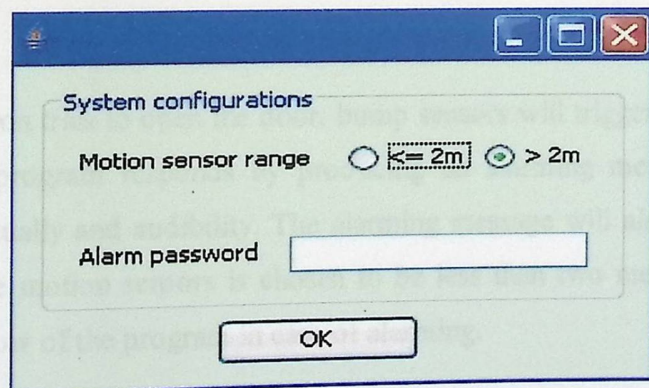


Fig. (5.7): Configuration Window

As mentioned previously, if the motion sensor ranges in the program is configured to be more than two meters, a warning message would be appeared on the screen graphically and textually, as shown in Figure (5.8).



Fig. (5.8): Warning Screenshot

If a person tries to open the door, bump sensors will trigger the voltage to go high, and the program responds by producing an alarming message represented graphically, textually and audibility. The alarming message will also be produced if the range of the motion sensors is chosen to be less than two meters. Figure (5.9) shows the window of the program in case of alarming.

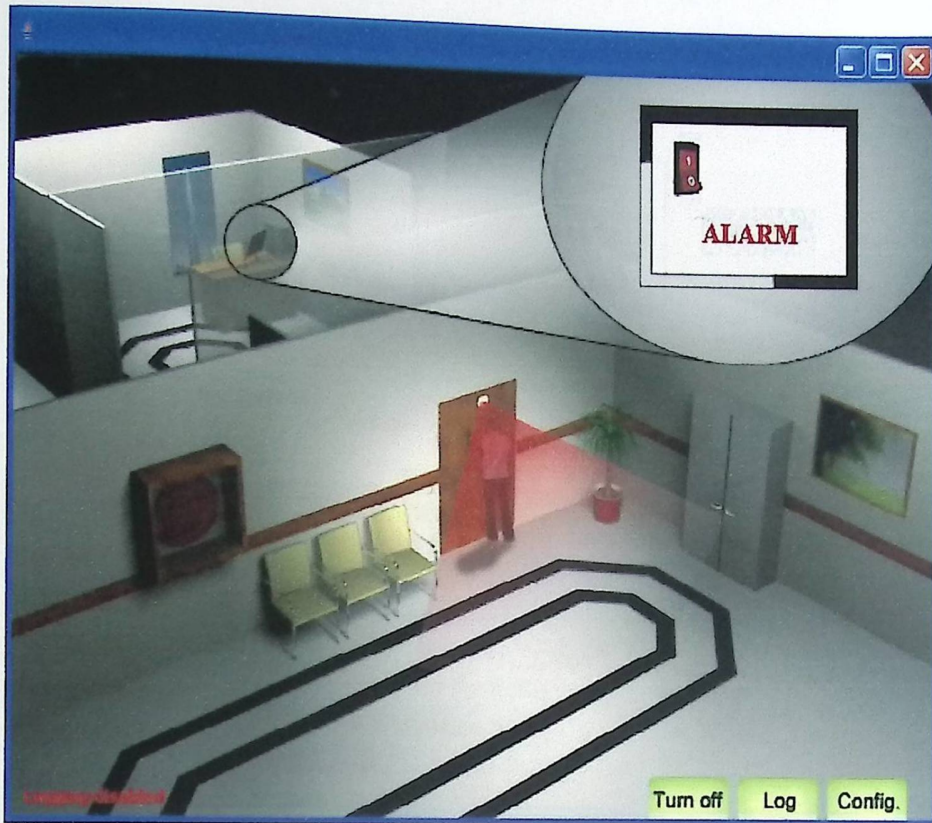


Fig. (5.9): Alarming Screenshot

In the program, when the alarm or warning is released, the user can switch it off, because when the off button is pressed, the program will prompt the user to enter a password. The following screenshots show the main windows of the program in the different cases. Figure (5.10) represents the flowchart of stopping the alarm. The alarm is still ON as long as the user does not enter the correct password

Fig. (5.10): Flowchart of Stopping the Alarm Process

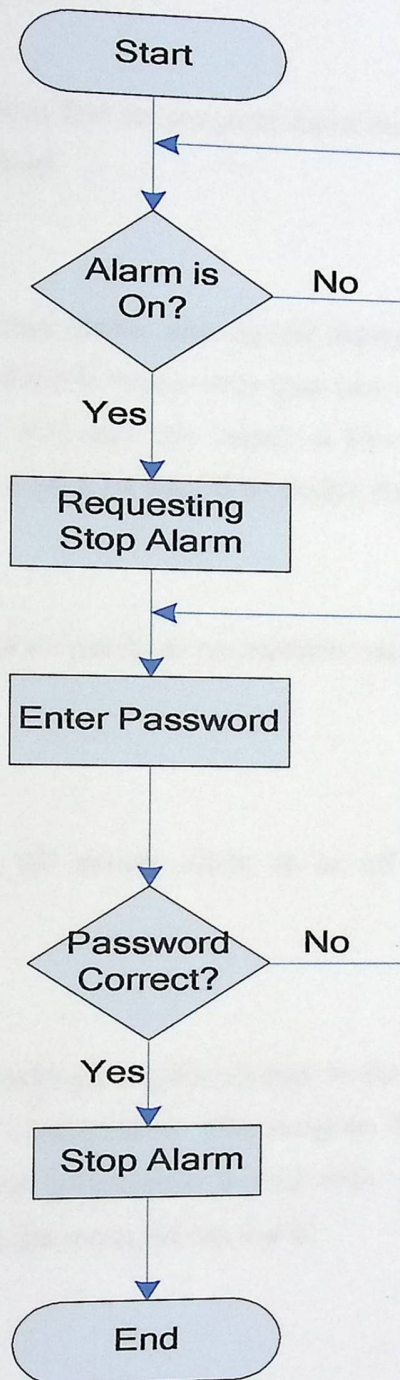


Fig. (5.10): Flowchart of Stopping the Alarm Process

At the end, we believe that the program meets the following non-functional requirements, as the followings:

- *Flexibility*: as explained above, warning and alarming are done in two stages, if the range of detection is chose more than two meters only the warning is released, and when it is only two meters or less the alarm will work. The ability to switch the system on and off is another flexibility feature.
- *Reliability*: the program provides transactions monitoring; all the events are recorded.
- *Security*: switching the system alarm on or off is done after entering a password.
- *Ease of operation*: making the program easy to use is an important factor that must be taken into consideration. This program does not require a security expert, or a computer programmer to deal with. Any person with a simple background in using the computer can use it.

5.3 Code Listing

This section represents only the code of the PIC, but the code of the JAVA program will be placed in the appendix.

LIST C=80,N=60,P=16C84,R=DEC

TITLE "PICPROG.ASM"

;

STATUS EQU 3 ;STATUS is file register 03h
PORTB EQU 6 ;PORTB is file register 06h
TRISB EQU 6 ;TRISB is file register 86h

PORTA EQU 5

TRISA EQU 5

RP0 EQU 5 ;RP0 is bit 5 of STATUS

A0 EQU 0

A1 EQU 1

B0 EQU 0

B1 EQU 1

;variables used for the delay subroutine

R0 EQU H'C'

R1 EQU H'D'

R2 EQU H'E'

COUNT1 EQU 10

COUNT2 EQU 50

;

;

*** MAIN PROGRAM ***

;

ORG 0

BSF STATUS,RP0 ;Select register page 1

```

                                MOVLW  H'FF'
DELAY  MOVWF  TRISA  ;SET PORT A AS INPUT
                                MOVLW  0
DELAY1 MOVWF  TRISB  ;Make PORTB all output
                                BCF    STATUS,RP0  ;Select register page 0

; DELAY2                                MOVLW  COUNT2
MOVWF  MOVLW  H'00'
                                MOVWF  PORTB
DELAY3                                BTFSC  PORTA, A0
CHECKA0 GOTO  A0SET
                                GOTO  A0RESET
                                GOTO  DELAY2

A0SET  BSF  PORTB, B0
                                GOTO  CHECKA1

A0RESET BCF  PORTB, B0
CHECKA1 BTFSC PORTA, A1
                                GOTO  A1SET
                                GOTO  A1RESET

A1SET  BSF  PORTB, B1
                                GOTO  NEXT

A1RESET BCF  PORTB, B1
NEXT   CALL  DELAY

                                MOVLW  H'00'  ;RESERT THE OUTPUT PINS
                                MOVWF  PORTB

                                GOTO  CHECKA0

```

```
DELAY          MOVWF R0

DELAY1        MOVLW COUNT1
              MOVWF R1

DELAY2        MOVLW COUNT2
              MOVWF R2

DELAY3        DECFSZ R2
              GOTO DELAY3

              DECFSZ R1
              GOTO DELAY2

              DECFSZ R0
              GOTO DELAY1
              RETURN
              END
```

Chapter Six System Implementation and Testing

Chapter

6 System Implementation and Testing

6.1 Actual Project Implementation.

6.2 Hardware Testing.

6.3 Software Testing.

Chapter Six

System Implementation and Testing

This chapter demonstrates the methods and procedures used to implement, test, and examine the system operation and behavior. System testing is an important and crucial step in implementing a system. It senses the effectiveness of that system just before introducing it to its users.

This system has more than one issue to be tested. Some testing parts reflect a software or hardware. In addition, testing procedures concentrate on a single device independent from the overall system.

6.1 Implementation

The implementation process is synchronized with the testing operation, since each implementation phase will take many testing steps to ensure that there are no errors.

The actual project implementation was a hardware prototype. The detailed description of each circuit implementation will be mentioned in the next section.

6.2 Hardware Testing

Here are the testing issues. They are not ordered in any manner; rather they represent a way of system integrity and operation:

6.2.1 Components Testing

We started to test each component of the project to ensure its functionality. Sensor testing was done by connecting each sensor circuit according to our project's needs, for instance, we connected the bump sensor in such a way that if it is pressured a high voltage will be produced, see Figure (6.1).

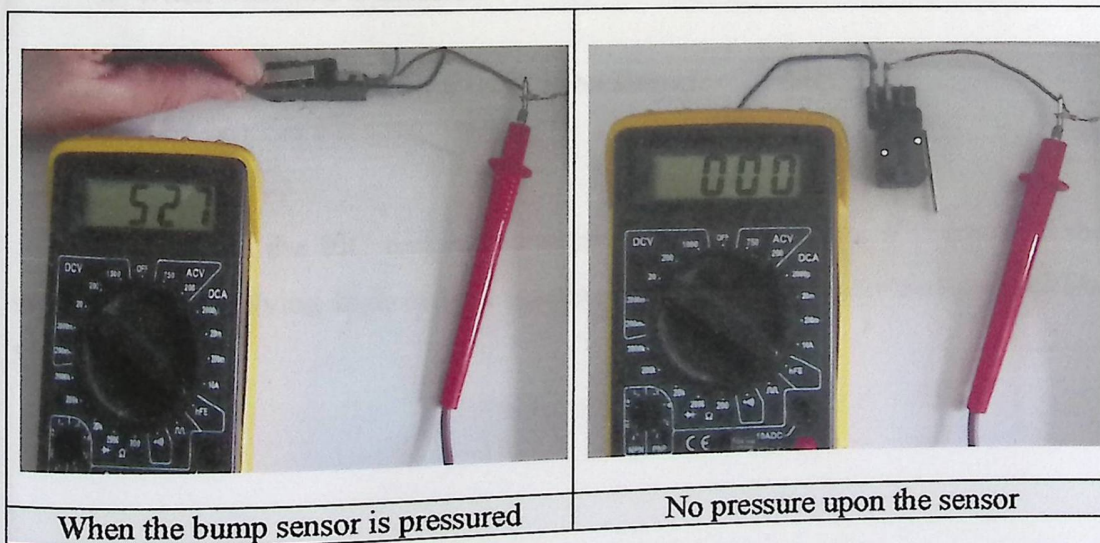


Fig. (6.1): Bump Sensor Testing

The range of the motion detector sensor was configured at the beginning to control the distance and angle of detection. Therefore, we tested this motion several times. As shown in Figure (6.2), when a motion is detected a 5 volt is produced.

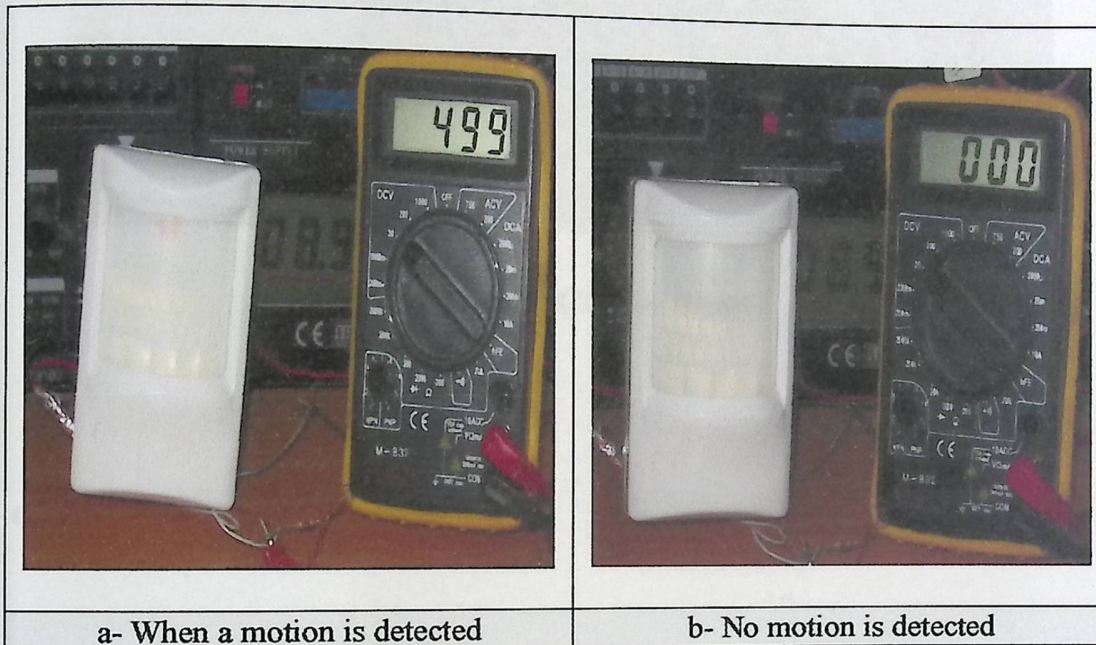


Fig. (6.2): PIR Motion Detector Testing

We tested the PIC without connecting the sensors to it. We controlled the input of it by applying high or low voltage, and observing the output using LEDs. See Figure (6.3).

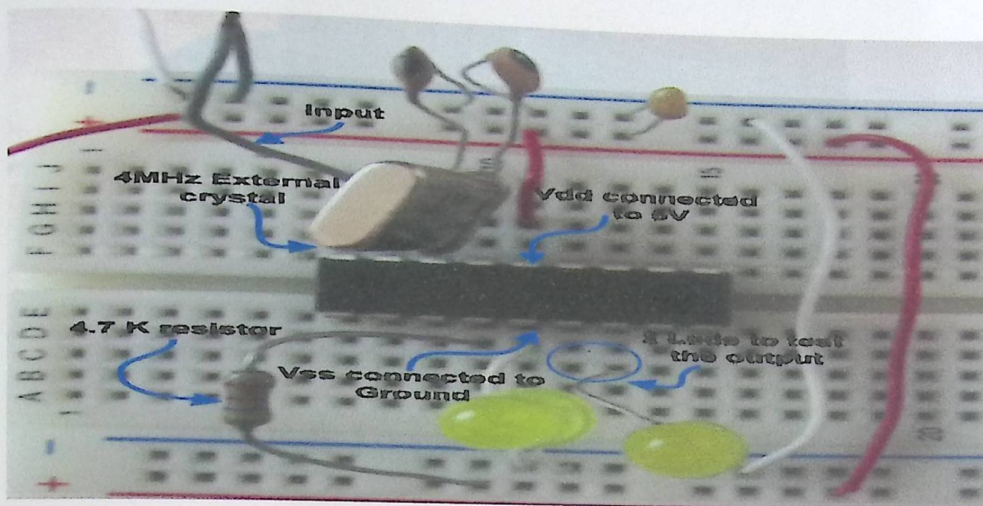


Fig. (6.3): PIC16F84 Board

At the second stage, we used a transmitter and receiver that had been connected to the encoder and decoder respectively, as shown in Figure (6.3). Then we tried to send the same signal but without connecting the decoder, the difference between the two signals is shown in Figure (6.4).

6.2.2 Communication Testing

At the first stages of the communication testing, with the help of the manufacturer's data sheets, the transmitter was powered up and connected to a function generator. The purpose of this test setup was to make sure that the wave that was outputted from the function generator was the same as the wave that was fed into the oscilloscope. The function generator was configured to output a digital wave between 0V and 5V with a frequency of 3 KHz. As expected, the same wave appeared on the oscilloscope, signifying that the data that was sent by the transmitter was the same as that received by the receiver. See Figure (6.4).

Fig. (6.4) Transmitter Board

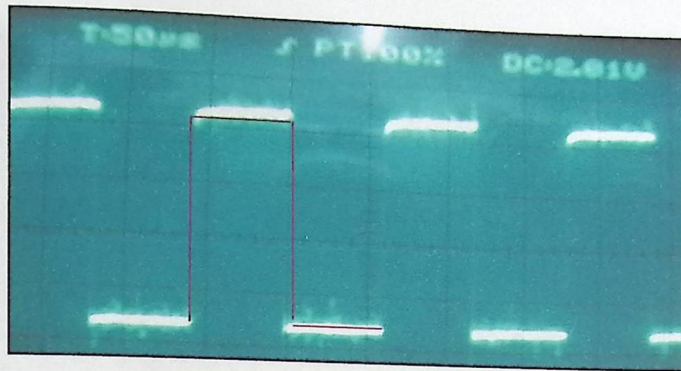


Fig. (6.4): Transmitter and Receiver Testing

At the second stage, we tested the transmitter and receiver that had been connected to the encoder and decoder respectively, as shown in Figure (6.5). Then we tried to send the same signal but without connecting the decoder, the difference between the two signals is shown in Figure (6.6).

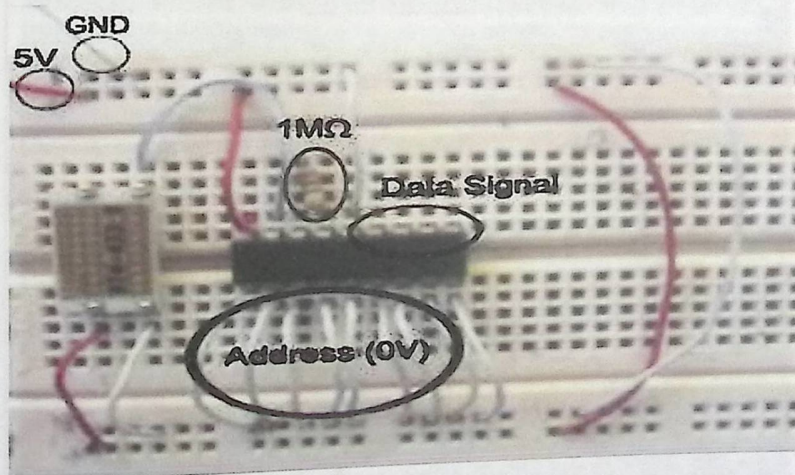


Fig. (6.5-a): Transmitter Board

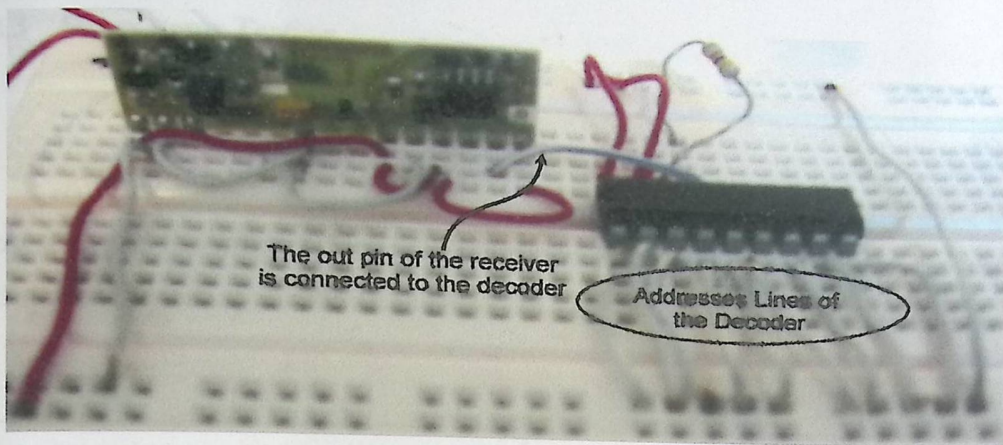


Fig. (6.5-b): Receiver Board

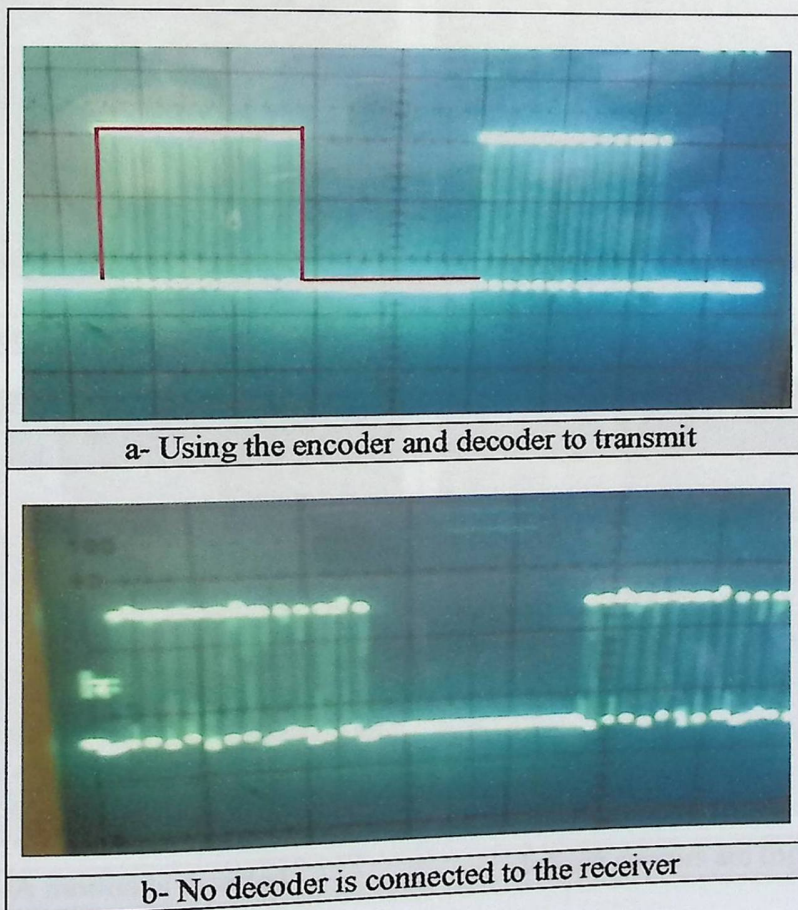


Fig. (6.6): Signal Testing

6.2.3 Subsystems Testing

After constructing each circuit, we started to integrate the circuits of the basic subsystems of the project. First, we connected the circuit of the PIC to the sensors and started the testing, as shown in Figure (6.7).

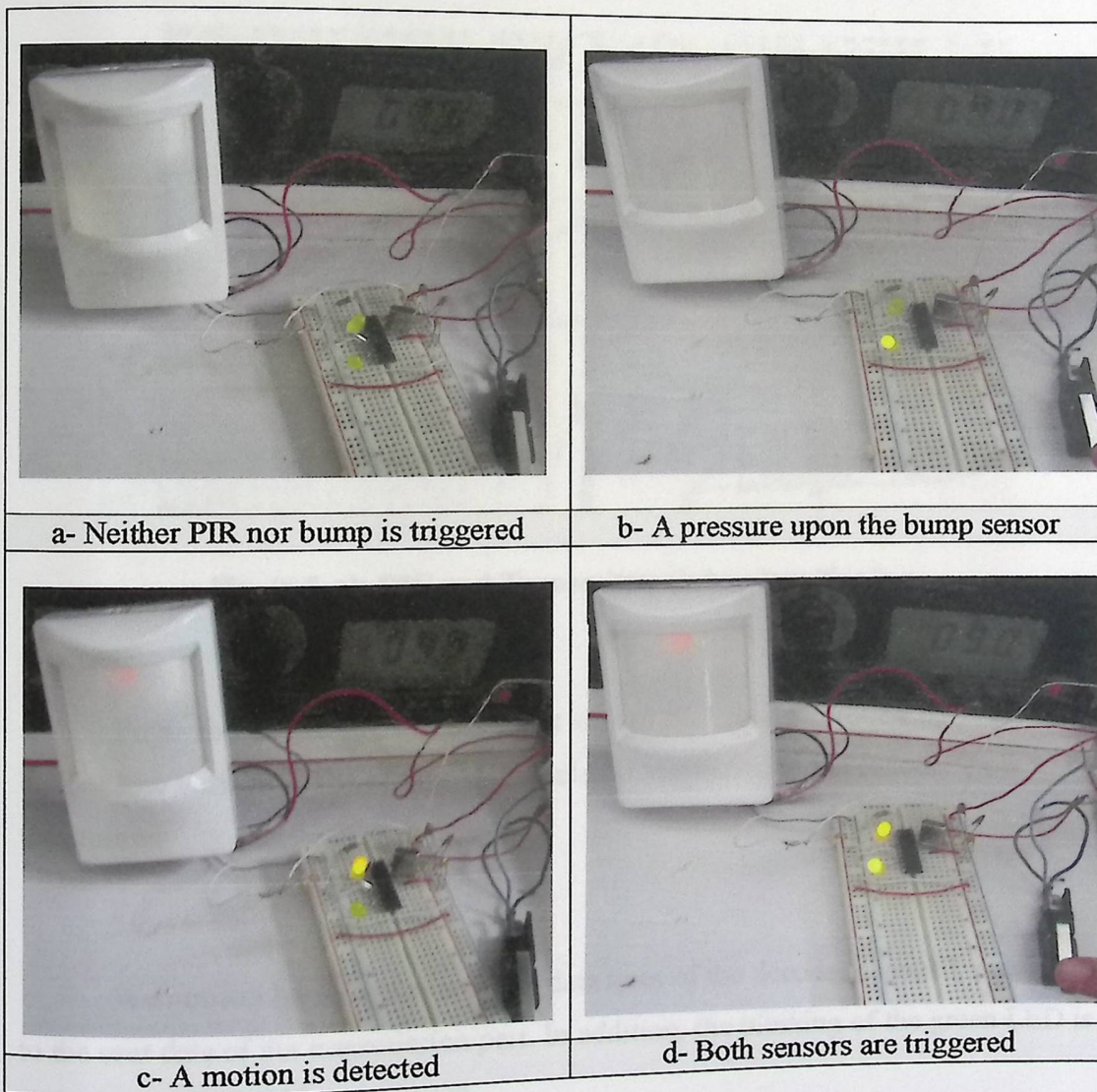


Fig. (6.7): PIC and Sensors Subsystem Testing

As shown in the above Figure, the four different states of the sensors were tested, and the output was determined according to the status of those sensors.

Then the transmission and receiving process was tested after connected the PIC to the encoder in the transmitter board, as shown in Figure (6.8).

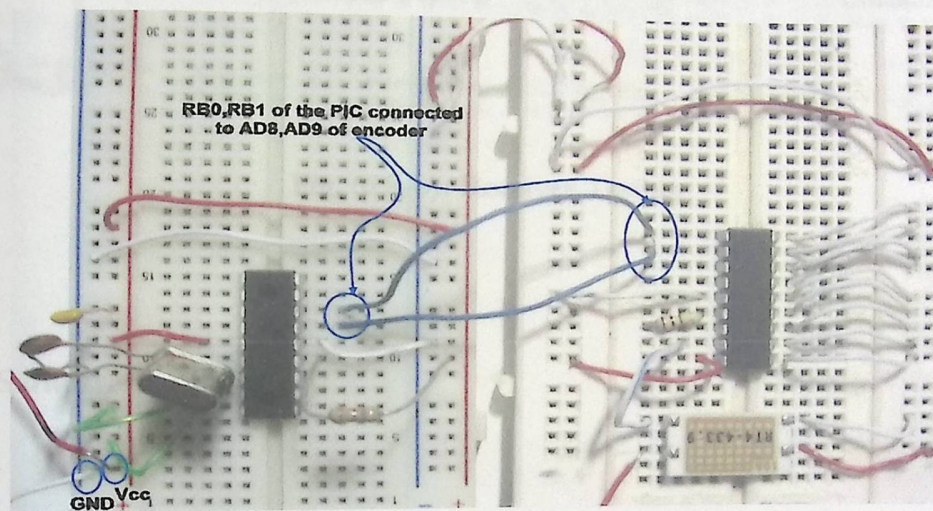


Fig. (6.8-a): PIC and Transmitter Subsystem Testing

From the above Figure, the input of the PIC was controlled by applying a high or low voltage so the output of it would be transferred to the encoder input to be transmitted.

We noticed how the status of the data lines of the decoder changed, according to the sent data of the transmission part. In addition, the blinking of the green LED is an indicator of the addresses match.

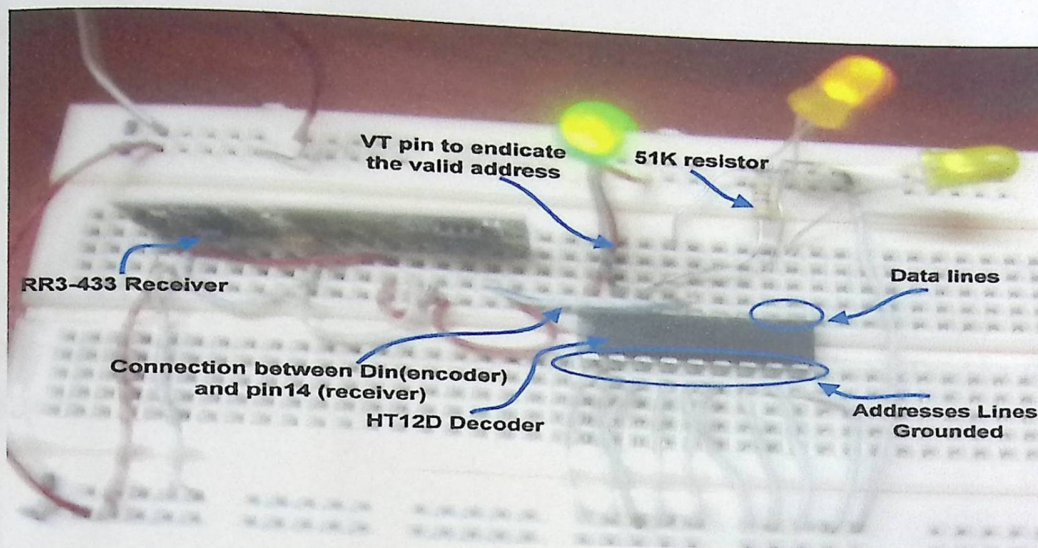


Fig. (6.8-b): Receiver Testing

6.3 Software Testing

The ultimate goal of the testing process is to establish confidence that the software system is 'fit for purpose'. This does not mean that the program must be completely free of defects. Rather, it means that the system must be good enough for its intended use. The level of required confidence depends on the systems' purpose, the expectations of the system users and the current marketing environment for the system.

Since we learn how to use PIC in our advanced microprocessor laboratory, we are familiar with this program, so it was the most convenient to download and use it. Determining the timing was the most problematic task; it took us long time and

several trials working on it. Finally, we managed to determine the time for delay, so as, to ensure the access of the sensors signals.

Next, it was significantly important to test the parallel port. Therefore, a simple program was designed to read the status of the two parallel port input lines. DIP switches were used to send 0 to 5 volts values to the input lines. Decoder data lines then replaced the switches.

Figure (6.8) shows a screenshot of the program that was used to control the operation of the parallel port, when the input button is pressed the program should continuously check the status line and show the results. The status reading remains ON as long as there is no high voltage on the pins.

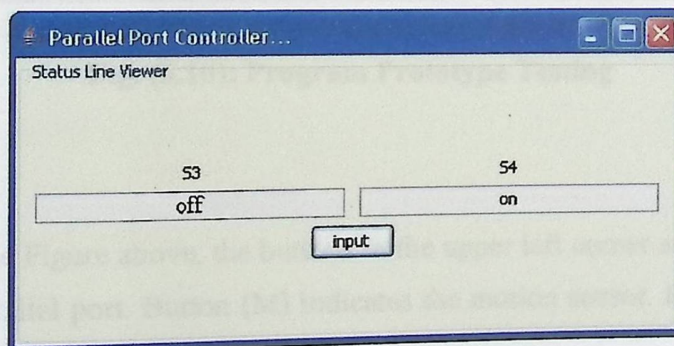


Fig. (6.9): Parallel Port Testing

After assuring that the program handled with the parallel port properly, the program was tested by replacing the inputs from the parallel port by two buttons. One is used as alternative for the motion detector, and the second as a

substitute of the bump sensor. The following Figure (6.9) illustrates the screenshot of the prototype of the program.



Fig. (6.10): Program Prototype Testing

From the Figure above, the buttons in the upper left corner are working as the input of the parallel port. Button (M) indicates the motion sensor. Button (A) works as the bump sensor.

Chapter Seven Conclusions and Future Works

Chapter

7 Conclusions and Future Works

7.1 Conclusions

7.2 Problems

7.3 Future Works

- * The most significant issues on this project were communication, training and documentation. Communicating with each other among the group members is extremely vital. Documentation needed to be available and more complete. The project took a lot longer than planned to get it up and running including creating a stable, user-friendly interface.

Chapter Seven

Conclusions and Future Works

This chapter introduces some significant points about the way of continuing do more and more in the field of the system concepts or tools. Also, it represents the conclusions extracted during designing and implementing it. The chapter illustrates the system implementation achievements and output.

7.1 Conclusions

Many experiences were added to the team cognitive knowledge through this project. Many conclusions can be stated here, but only significant and important ones are described:

- The most significant issues on this project were communication, training and documentation. Communicating with each other among the group members is extremely vital. Documentation needed to be available and more complete. The project took a lot longer than planned to get it up and running including creating a stable, user-friendly interface.

- Building this security system was a great way of combining all we have learned over the five years at PPU. We were able to design, build and implement the project. We learned how to manage our time when things were slow.
 - This project was a challenge for us, as the team spent 30-40 hours a week working on this project in the last month. We learned a lot and used everything we had learned in our classes to solve the problems and come up with solutions to make this security system work. We had encountered many limitations and problems on this project that made it even more challenging.
 - There is a big difference between the theories and the real world implementation.
 - This project proved that our ideas were viable for implementation in a project that resembles a real-life problem.
 - During this semester, the most important phases of our project took place, including: schematics building, devices availability, device testing, sub-systems testing and implementation, and system upgrading and programming. All of that were introduced in the next three chapters prepared in this semester.
- 7.2 Problems
- Each device was tested individually in its own circuit to study its behavior and make sure it works properly and can do its expected job.
 - Each subsystem was implemented in its own circuit and tested by means of Hardware and Software. At the next testing stage two or more subsystems were combined together to check the influence of their outputs on each other. Then the

whole system would be upgraded to check its work and test the complete system program on it.

- Our project is a security system with two or more sensors that will be placed at the door that is able to sense a person trying to open it; the system will then give you a warning and the time to check the try of any intrusion. Therefore, our final project consists of several sensors with each having a different objective.
- Using the encoder and decoder guarantees the matching between the sent signals from the door and the received ones on the computer side.
- We make sure that the signals will be sent to its destination on the receiver side by using the same addresses of the encoder and decoder. This would decrease the possibility of interfering between the sent signal and other signals.
- Using the parallel port to retrieve the data that were sent is much easier than using the serial one, because there is no need for synchronizing process.

7.2 Problems

System completion in regard to its objectives is an implementation dependent issue. Problems are natural things. Encountering problems and limitations is very common in such a huge project specially when dealing with electronic devices. We were able to solve all the problems and come over all difficulties we faced.

Here are problems faced the project team during the system implementation:

- When we started our work on the project, we had built prototypes for all circuits using old breadboards from the university lab, which led into damage for some integrated chips (ICs).
- Internal damage in some devices due to the wrong connections, or high voltages, or currents supplied to the devices during the implementation.
- Time and effort were wasted because of the bad choices we have made, such as:
 - In the first semester we decided to use PIC18F877, but the missing of the linker files of PIC forced us not to use it.
 - We moved into using PIC18F4520, but since this decision was made just in this semester, we spent many weeks to study the datasheet of it and learn to use the MPLAB software that is used for programming the PIC.

7.3 Future Work:

We tried our best to choose the rational design to achieve the objectives of our project. We also believe that any work can not reach the perfection. Still a lot of thought and ideas can be utilized to enhance the current work achieved. Here are some of them:

- Providing a camera on the door so the image would be sent wirelessly.
- The ability of the program to send short message service (SMS). This can be used to make it easier, faster, and more convenient to detect and convey the information if any intrusion is detected.
- Features can be added to our program to enhance the functionality of the project. Automatically dialing up a phone number to alter for any intrusion.
- In addition to the computer, a PIC can be added on the receiving side.

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Appendix B: Source Code

Appendices

Appendix A: Datasheets of Project Components

Appendix B: Source Code



MICROCHIP

Appendix A:

PIC16F84A

Data Sheet

Datasheets of Project Components

**EEPROM
8-bit Microcontroller**



PIC16F84A Data Sheet

18-pin Enhanced FLASH/EEPROM 8-bit Microcontroller

DS35007B

Note the following details of the code protection feature on PICmicro® MCUs.

- The PICmicro family meets the specifications contained in the Microchip Data Sheet.
- Microchip believes that its family of PICmicro microcontrollers is one of the most secure products of its kind on the market today, when used in the intended manner and under normal conditions.
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- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable".
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MICROCHIP

PIC16F84A

18-pin Enhanced FLASH/EEPROM 8-Bit Microcontroller

High Performance RISC CPU Features:

- Only 35 single word instructions to learn
- All instructions single-cycle except for program branches which are two-cycle
- Operating speed: DC - 20 MHz clock input
DC - 200 ns instruction cycle
- 1024 words of program memory
- 68 bytes of Data RAM
- 64 bytes of Data EEPROM
- 14-bit wide instruction words
- 8-bit wide data bytes
- 15 Special Function Hardware registers
- Eight-level deep hardware stack
- Direct, indirect and relative addressing modes
- Four interrupt sources:
 - External RB0/INT pin
 - TMR0 timer overflow
 - PORTB<7:4> interrupt-on-change
 - Data EEPROM write complete

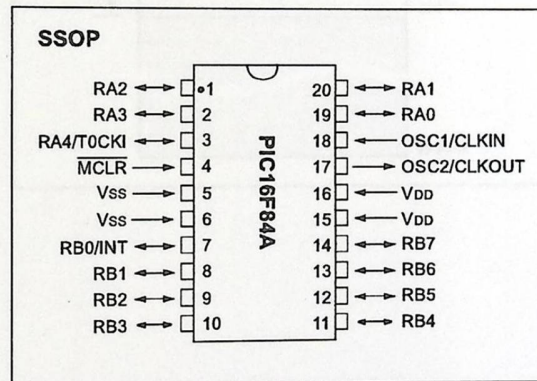
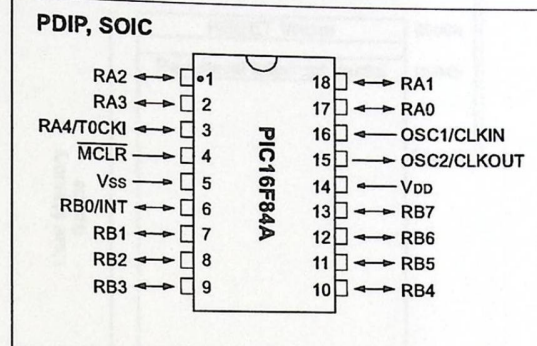
Peripheral Features:

- 13 I/O pins with individual direction control
- High current sink/source for direct LED drive
 - 25 mA sink max. per pin
 - 25 mA source max. per pin
- TMR0: 8-bit timer/counter with 8-bit programmable prescaler

Special Microcontroller Features:

- 10,000 erase/write cycles Enhanced FLASH Program memory typical
- 10,000,000 typical erase/write cycles EEPROM Data memory typical
- EEPROM Data Retention > 40 years
- In-Circuit Serial Programming™ (ICSP™) - via two pins
- Power-on Reset (POR), Power-up Timer (PWRT), Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own On-Chip RC Oscillator for reliable operation
- Code protection
- Power saving SLEEP mode
- Selectable oscillator options

Pin Diagrams



CMOS Enhanced FLASH/EEPROM Technology:

- Low power, high speed technology
- Fully static design
- Wide operating voltage range:
 - Commercial: 2.0V to 5.5V
 - Industrial: 2.0V to 5.5V
- Low power consumption:
 - < 2 mA typical @ 5V, 4 MHz
 - 15 µA typical @ 2V, 32 kHz
 - < 0.5 µA typical standby current @ 2V

2.0 MEMORY ORGANIZATION

There are two memory blocks in the PIC16F84A. These are the program memory and the data memory. Each block has its own bus, so that access to each block can occur during the same oscillator cycle.

The data memory can further be broken down into the general purpose RAM and the Special Function Registers (SFRs). The operation of the SFRs that control the "core" are described here. The SFRs used to control the peripheral modules are described in the section discussing each individual peripheral module.

The data memory area also contains the data EEPROM memory. This memory is not directly mapped into the data memory, but is indirectly mapped. That is, an indirect address pointer specifies the address of the data EEPROM memory to read/write. The 64 bytes of data EEPROM memory have the address range 0h-3Fh. More details on the EEPROM memory can be found in Section 3.0.

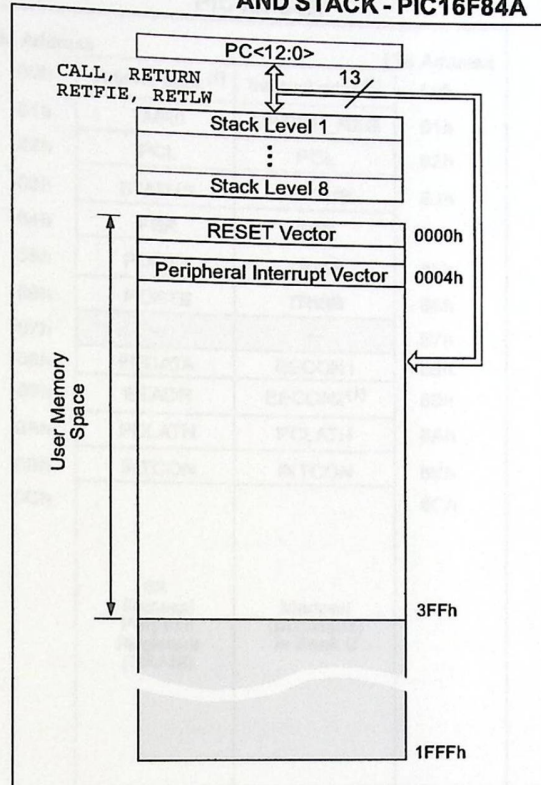
Additional information on device memory may be found in the PICmicro™ Mid-Range Reference Manual, (DS33023).

2.1 Program Memory Organization

The PIC16FXX has a 13-bit program counter capable of addressing an 8K x 14 program memory space. For the PIC16F84A, the first 1K x 14 (0000h-03FFh) are physically implemented (Figure 2-1). Accessing a location above the physically implemented address will cause a wraparound. For example, for locations 20h, 420h, 820h, C20h, 1020h, 1420h, 1820h, and 1C20h, the instruction will be the same.

The RESET vector is at 0000h and the interrupt vector is at 0004h.

FIGURE 2-1: PROGRAM MEMORY MAP AND STACK - PIC16F84A



PIC16F84A

2.2 Data Memory Organization

The data memory is partitioned into two areas. The first is the Special Function Registers (SFR) area, while the second is the General Purpose Registers (GPR) area. The SFRs control the operation of the device.

Portions of data memory are banked. This is for both the SFR area and the GPR area. The GPR area is banked to allow greater than 116 bytes of general purpose RAM. The banked areas of the SFR are for the registers that control the peripheral functions. Banking requires the use of control bits for bank selection. These control bits are located in the STATUS Register. Figure 2-2 shows the data memory map organization.

Instructions MOVWF and MOVF can move values from the W register to any location in the register file ("F"), and vice-versa.

The entire data memory can be accessed either directly using the absolute address of each register file or indirectly through the File Select Register (FSR) (Section 2.5). Indirect addressing uses the present value of the RP0 bit for access into the banked areas of data memory.

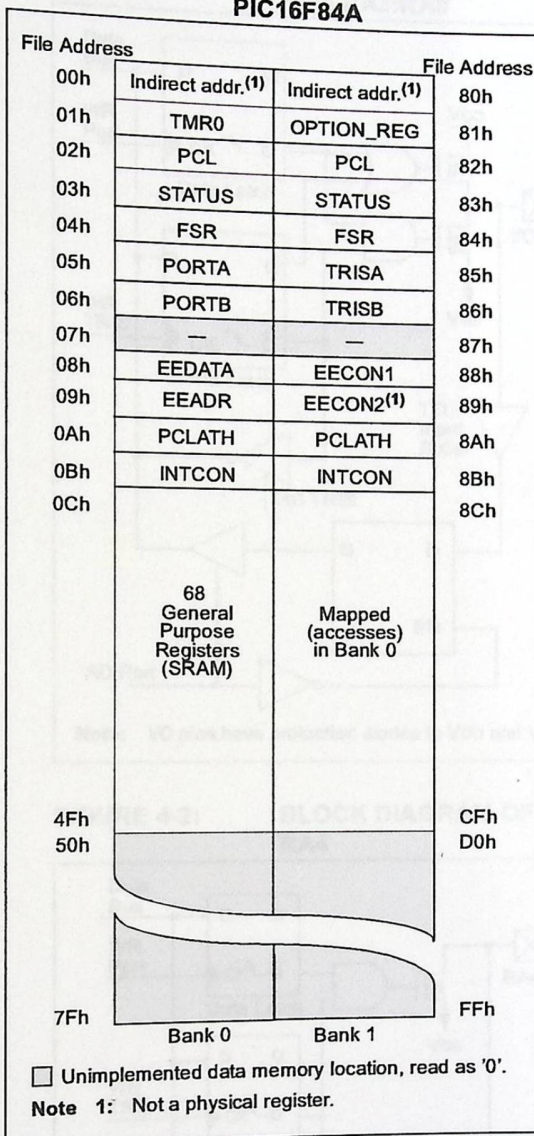
Data memory is partitioned into two banks which contain the general purpose registers and the special function registers. Bank 0 is selected by clearing the RP0 bit (STATUS<5>). Setting the RP0 bit selects Bank 1. Each Bank extends up to 7Fh (128 bytes). The first twelve locations of each Bank are reserved for the Special Function Registers. The remainder are General Purpose Registers, implemented as static RAM.

2.2.1 GENERAL PURPOSE REGISTER FILE

Each General Purpose Register (GPR) is 8-bits wide and is accessed either directly or indirectly through the FSR (Section 2.5).

The GPR addresses in Bank 1 are mapped to addresses in Bank 0. As an example, addressing location 0Ch or 8Ch will access the same GPR.

FIGURE 2-2: REGISTER FILE MAP - PIC16F84A



PIC16F84A

4.0 I/O PORTS

Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

Additional information on I/O ports may be found in the PICmicro™ Mid-Range Reference Manual (DS33023).

4.1 PORTA and TRISA Registers

PORTA is a 5-bit wide, bi-directional port. The corresponding data direction register is TRISA. Setting a TRISA bit (= 1) will make the corresponding PORTA pin an input (i.e., put the corresponding output driver in a Hi-Impedance mode). Clearing a TRISA bit (= 0) will make the corresponding PORTA pin an output (i.e., put the contents of the output latch on the selected pin).

Note: On a Power-on Reset, these pins are configured as inputs and read as '0'.

Reading the PORTA register reads the status of the pins, whereas writing to it will write to the port latch. All write operations are read-modify-write operations. Therefore, a write to a port implies that the port pins are read. This value is modified and then written to the port data latch.

Pin RA4 is multiplexed with the Timer0 module clock input to become the RA4/T0CKI pin. The RA4/T0CKI pin is a Schmitt Trigger input and an open drain output. All other RA port pins have TTL input levels and full CMOS output drivers.

EXAMPLE 4-1: INITIALIZING PORTA

```
BCF STATUS, RPO ;
CLRF PORTA      ; Initialize PORTA by
                 ; clearing output
                 ; data latches
BSF STATUS, RPO ; Select Bank 1
MOVLW 0x0F      ; Value used to
                 ; initialize data
                 ; direction
MOVWF TRISA     ; Set RA<3:0> as inputs
                 ; RA4 as output
                 ; TRISA<7:5> are always
                 ; read as '0'.
```

FIGURE 4-1: BLOCK DIAGRAM OF PINS RA3:RA0

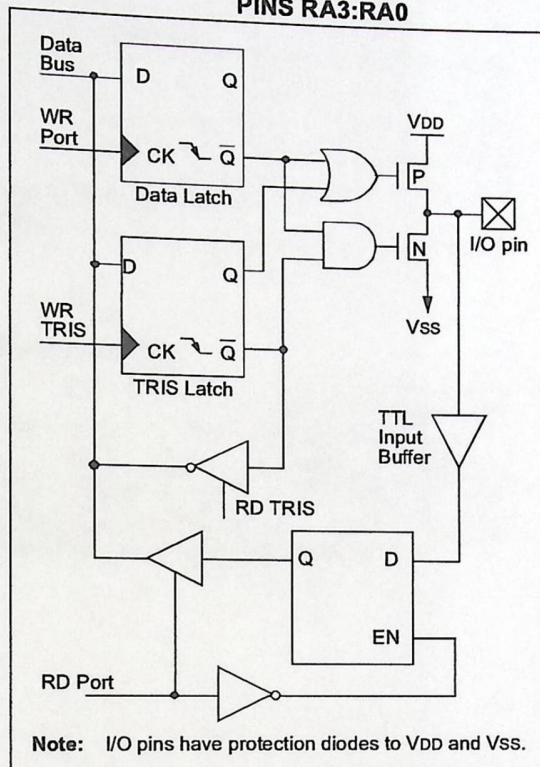
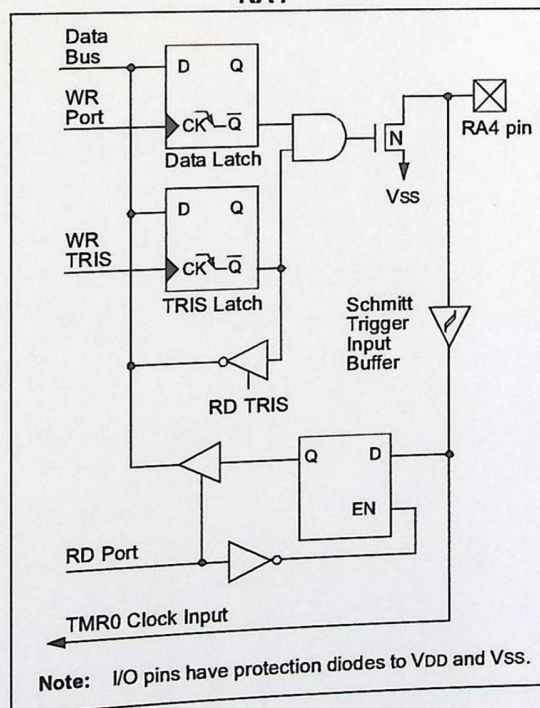


FIGURE 4-2: BLOCK DIAGRAM OF PIN RA4



PIC16F84A

TABLE 4-1: PORTA FUNCTIONS

Name	Bit0	Buffer Type	Function
RA0	bit0	TTL	Input/output
RA1	bit1	TTL	Input/output
RA2	bit2	TTL	Input/output
RA3	bit3	TTL	Input/output
RA4/T0CKI	bit4	ST	Input/output or external clock input for TMR0. Output is open drain type.

Legend: TTL = TTL input, ST = Schmitt Trigger input

TABLE 4-2: SUMMARY OF REGISTERS ASSOCIATED WITH PORTA

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on Power-on Reset	Value on all other RESETS
05h	PORTA	—	—	—	RA4/T0CKI	RA3	RA2	RA1	RA0	---x xxxx	---u uuuu
85h	TRISA	—	—	—	TRISA4	TRISA3	TRISA2	TRISA1	TRISA0	---1 1111	---1 1111

Legend: x = unknown, u = unchanged, - = unimplemented, read as '0'. Shaded cells are unimplemented, read as '0'.

PIC16F84A

TABLE 4-3: PORTB FUNCTIONS

Name	Bit	Buffer Type	I/O Consistency Function
RB0/INT	bit0	TTL/ST ⁽¹⁾	Input/output pin or external interrupt input. Internal software programmable weak pull-up.
RB1	bit1	TTL	Input/output pin. Internal software programmable weak pull-up.
RB2	bit2	TTL	Input/output pin. Internal software programmable weak pull-up.
RB3	bit3	TTL	Input/output pin. Internal software programmable weak pull-up.
RB4	bit4	TTL	Input/output pin (with interrupt-on-change). Internal software programmable weak pull-up.
RB5	bit5	TTL	Input/output pin (with interrupt-on-change). Internal software programmable weak pull-up.
RB6	bit6	TTL/ST ⁽²⁾	Input/output pin (with interrupt-on-change). Internal software programmable weak pull-up. Serial programming clock.
RB7	bit7	TTL/ST ⁽²⁾	Input/output pin (with interrupt-on-change). Internal software programmable weak pull-up. Serial programming data.

Legend: TTL = TTL input, ST = Schmitt Trigger.

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.

Note 2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.

TABLE 4-4: SUMMARY OF REGISTERS ASSOCIATED WITH PORTB

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on Power-on Reset	Value on all other RESETS
06h	PORTB	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0/INT	xxxx xxxx	uuuu uuuu
86h	TRISB	TRISB7	TRISB6	TRISB5	TRISB4	TRISB3	TRISB2	TRISB1	TRISB0	1111 1111	1111 1111
81h	OPTION_REG	RBPU	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0	1111 1111	1111 1111
0Bh,8Bh	INTCON	GIE	EEIE	T0IE	INTE	RBIE	T0IF	INTF	RBIF	0000 000x	0000 000u

Legend: x = unknown, u = unchanged. Shaded cells are not used by PORTB.

PIC16F84A

6.2 Oscillator Configurations

6.2.1 OSCILLATOR TYPES

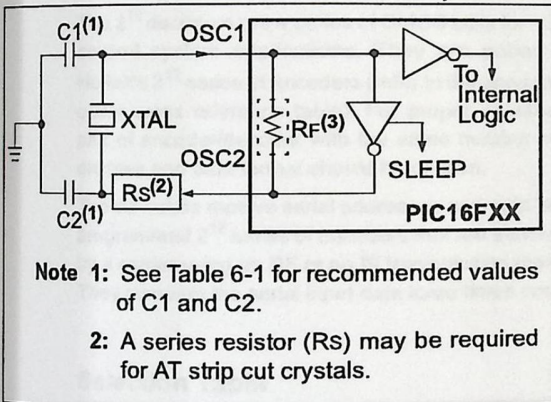
The PIC16F84A can be operated in four different oscillator modes. The user can program two configuration bits (FOSC1 and FOSC0) to select one of these four modes:

- LP Low Power Crystal
- XT Crystal/Resonator
- HS High Speed Crystal/Resonator
- RC Resistor/Capacitor

6.2.2 CRYSTAL OSCILLATOR/CERAMIC RESONATORS

In XT, LP, or HS modes, a crystal or ceramic resonator is connected to the OSC1/CLKIN and OSC2/CLKOUT pins to establish oscillation (Figure 6-1).

FIGURE 6-1: CRYSTAL/CERAMIC RESONATOR OPERATION (HS, XT OR LP OSC CONFIGURATION)



The PIC16F84A oscillator design requires the use of a parallel cut crystal. Use of a series cut crystal may give a frequency out of the crystal manufacturers specifications. When in XT, LP, or HS modes, the device can have an external clock source to drive the OSC1/CLKIN pin (Figure 6-2).

FIGURE 6-2: EXTERNAL CLOCK INPUT OPERATION (HS, XT OR LP OSC CONFIGURATION)

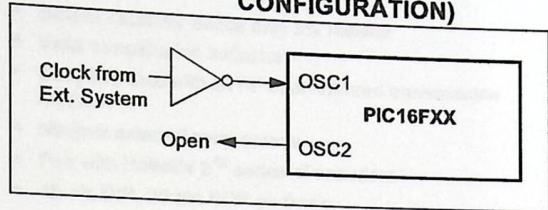


TABLE 6-1: CAPACITOR SELECTION FOR CERAMIC RESONATORS

Ranges Tested:			
Mode	Freq	OSC1/C1	OSC2/C2
XT	455 kHz	47 - 100 pF	47 - 100 pF
	2.0 MHz	15 - 33 pF	15 - 33 pF
	4.0 MHz	15 - 33 pF	15 - 33 pF
HS	8.0 MHz	15 - 33 pF	15 - 33 pF
	10.0 MHz	15 - 33 pF	15 - 33 pF

Note: Recommended values of C1 and C2 are identical to the ranges tested in this table. Higher capacitance increases the stability of the oscillator, but also increases the start-up time. These values are for design guidance only. Since each resonator has its own characteristics, the user should consult the resonator manufacturer for the appropriate values of external components.

Note: When using resonators with frequencies above 3.5 MHz, the use of HS mode rather than XT mode, is recommended. HS mode may be used at any VDD for which the controller is rated.

HT12D/HT12F 2¹² Series of Decoders

Features

- Operating voltage: 2.4V~12V
- Low power and high noise immunity CMOS technology
- Low standby current
- Capable of decoding 12 bits of information
- Binary address setting
- Received codes are checked 3 times
- Address/Data number combination
 - HT12D: 8 address bits and 4 data bits
 - HT12F: 12 address bits only
- Built-in oscillator needs only 5% resistor
- Valid transmission indicator
- Easy interface with an RF or an infrared transmission medium
- Minimal external components
- Pair with Holtek's 2¹² series of encoders
- 18-pin DIP, 20-pin SOP package

Applications

- Burglar alarm system
- Smoke and fire alarm system
- Garage door controllers
- Car door controllers
- Car alarm system
- Security system
- Cordless telephones
- Other remote control systems

General Description

The 2¹² decoders are a series of CMOS LSIs for remote control system applications. They are paired with Holtek's 2¹² series of encoders (refer to the encoder/decoder cross reference table). For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen.

The decoders receive serial addresses and data from a programmed 2¹² series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continu-

ously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission.

The 2¹² series of decoders are capable of decoding informations that consist of N bits of address and 12-N bits of data. Of this series, the HT12D is arranged to provide 8 address bits and 4 data bits, and HT12F is used to decode 12 bits of address information.

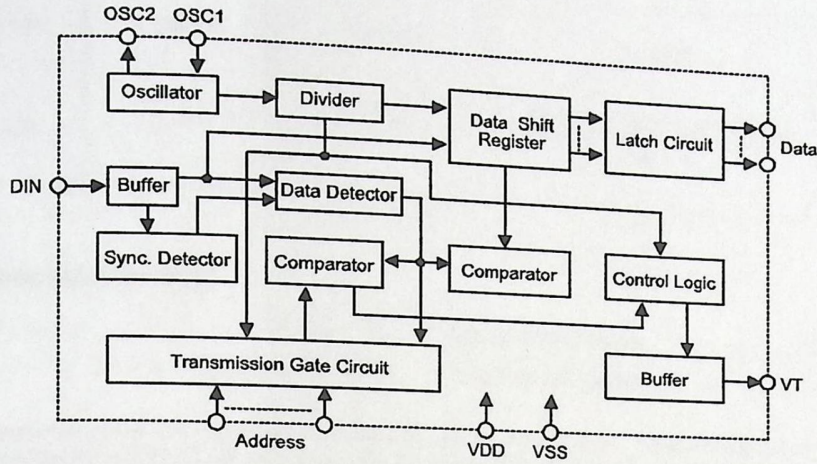
Selection Table

Part No.	Function	Address No.	Data		VT	Oscillator	Trigger	Package
			No.	Type				
HT12D		8	4	L	√	RC oscillator	DIN active "Hi"	18DIP, 20SOP
HT12F		12	0	—	√	RC oscillator	DIN active "Hi"	18DIP, 20SOP

Notes: Data type: L stands for latch type data output.

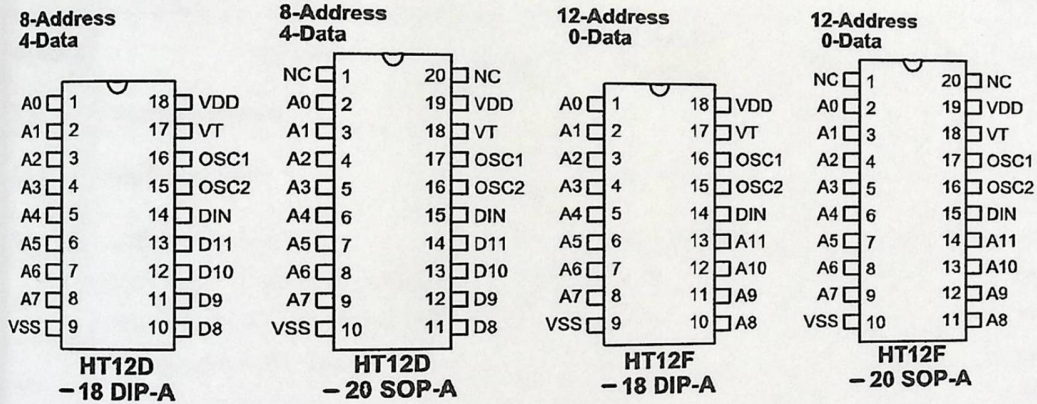
VT can be used as a momentary data output.

Block Diagram



Note: The address/data pins are available in various combinations (see the address/data table).

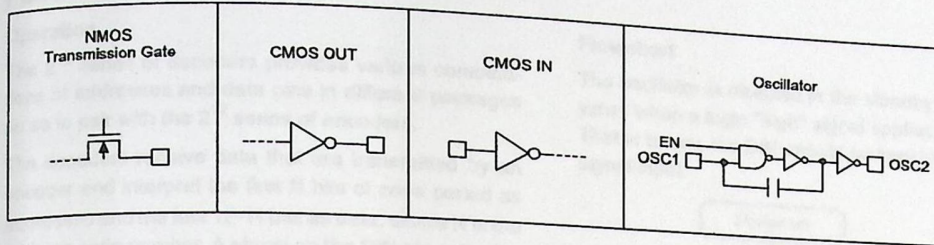
Pin Assignment



Pin Description

Pin Name	I/O	Internal Connection	Description
A0~A11 (HT12F)	I	NMOS Transmission Gate	Input pins for address A0~A11 setting These pins can be externally set to VSS or left open.
A0~A7 (HT12D)			Input pins for address A0~A7 setting These pins can be externally set to VSS or left open.
D8~D11 (HT12D)	O	CMOS OUT	Output data pins, power-on state is low.
DIN	I	CMOS IN	Serial data input pin
VT	O	CMOS OUT	Valid transmission, active high
OSC1	I	Oscillator	Oscillator input pin
OSC2	O	Oscillator	Oscillator output pin
VSS	---	---	Negative power supply, ground
VDD	—	—	Positive power supply

November 18, 2002

Approximate internal connection circuits

Absolute Maximum Ratings

Supply Voltage	-0.3V to 13V	Storage Temperature	-50°C to 125°C
Input Voltage	$V_{SS}-0.3$ to $V_{DD}+0.3V$	Operating Temperature.....	-20°C to 75°C

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

Electrical Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DD}	Operating Voltage	---	---	2.4	5	12	V
I _{STB}	Standby Current	5V	Oscillator stops	—	0.1	1	μA
		12V		—	2	4	μA
I _{DD}	Operating Current	5V	No load, f _{OSC} =150kHz	—	200	400	μA
I _O	Data Output Source Current (D8~D11)	5V	V _{OH} =4.5V	-1	-1.6	—	mA
	Data Output Sink Current (D8~D11)	5V	V _{OL} =0.5V	1	1.6	—	mA
I _{VT}	VT Output Source Current	5V	V _{OH} =4.5V	-1	-1.6	—	mA
	VT Output Sink Current		V _{OL} =0.5V	1	1.6	—	mA
V _{IH}	"H" Input Voltage	5V	—	3.5	—	5	V
V _{IL}	"L" Input Voltage	5V	---	0	---	1	V
f _{osc}	Oscillator Frequency	5V	R _{osc} =51kΩ	---	150	—	kHz

Functional Description

Operation

The 2¹² series of decoders provides various combinations of addresses and data pins in different packages so as to pair with the 2¹² series of encoders.

The decoders receive data that are transmitted by an encoder and interpret the first N bits of code period as addresses and the last 12-N bits as data, where N is the address code number. A signal on the DIN pin activates the oscillator which in turn decodes the incoming address and data. The decoders will then check the received address three times continuously. If the received address codes all match the contents of the decoder's local address, the 12-N bits of data are decoded to activate the output pins and the VT pin is set high to indicate a valid transmission. This will last unless the address code is incorrect or no signal is received.

The output of the VT pin is high only when the transmission is valid. Otherwise it is always low.

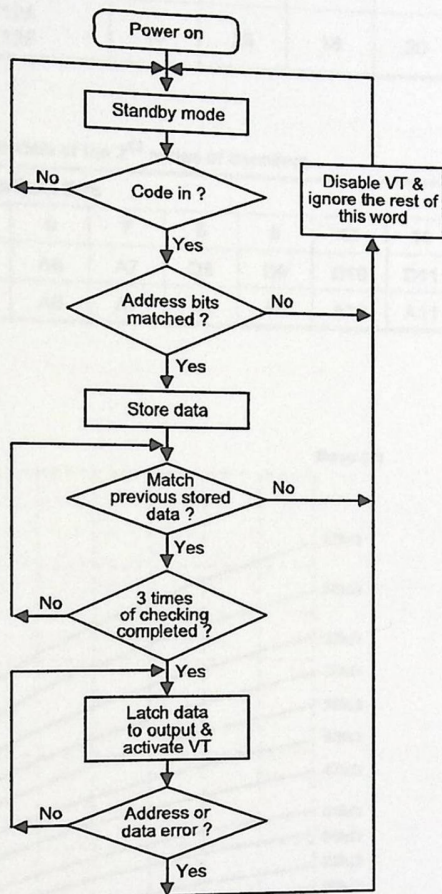
Output type

Of the 2¹² series of decoders, the HT12F has no data output pin but its VT pin can be used as a momentary data output. The HT12D, on the other hand, provides 4 latch type data pins whose data remain unchanged until new data are received.

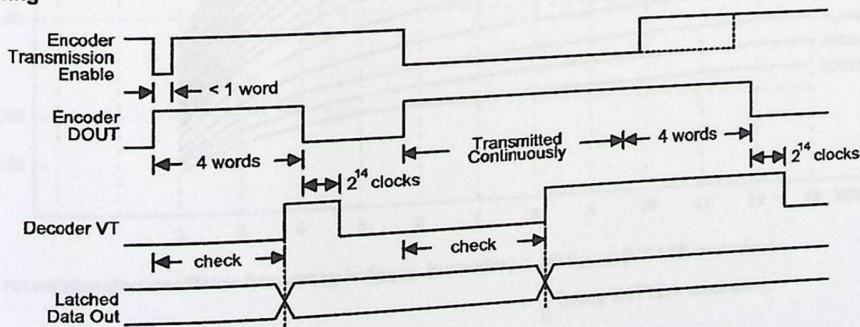
Part No.	Data Pins	Address Pins	Output Type	Operating Voltage
HT12D	4	8	Latch	2.4V~12V
HT12F	0	12	—	2.4V~12V

Flowchart

The oscillator is disabled in the standby state and activated when a logic "high" signal applies to the DIN pin. That is to say, the DIN should be kept low if there is no signal input.



Decoder timing



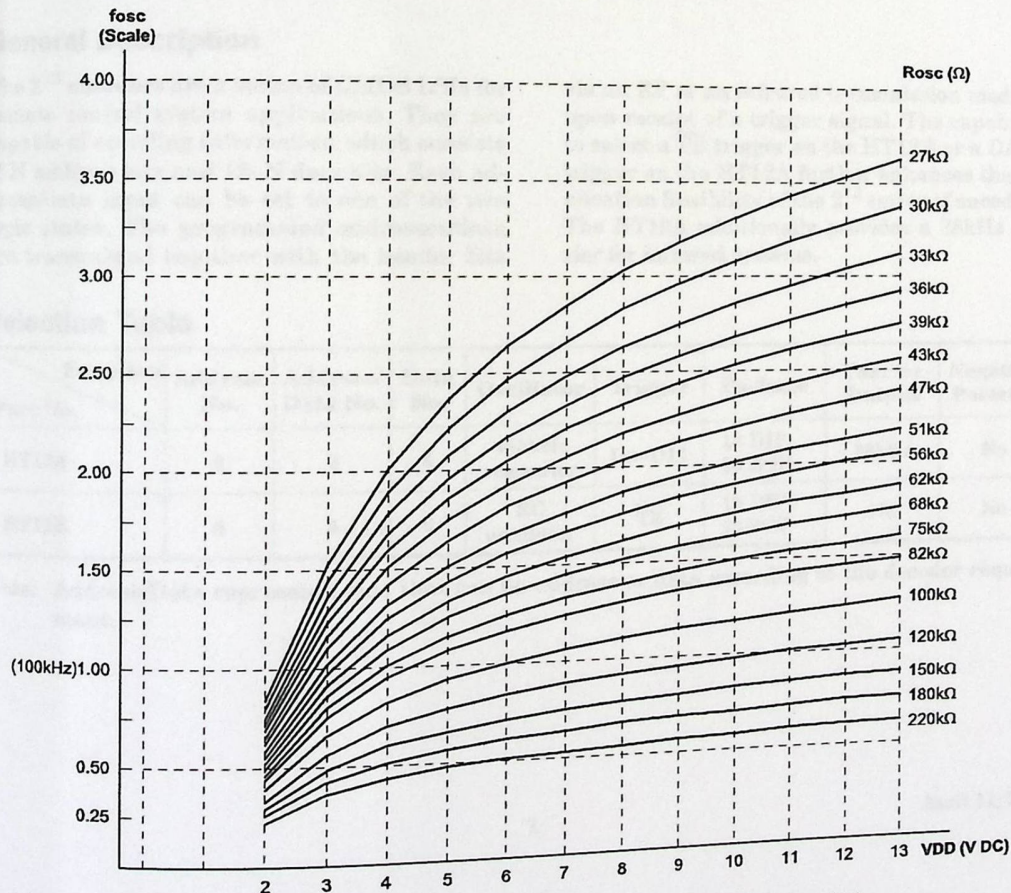
Encoder/Decoder cross reference table

Decoders Part No.	Data Pins	Address Pins	VT	Pair Encoder	Package			
					Encoder		Decoder	
					DIP	SOP	DIP	SOP
HT12D	4	8	√	HT12A HT12E	18	20	18	20
HT12F	0	12	√	HT12A HT12E	18	20	18	20

Address/Data sequence

The following table provides address/data sequence for various models of the 2¹² series of decoders.

Part No.	Address/Data Bits											
	0	1	2	3	4	5	6	7	8	9	10	11
HT12D	A0	A1	A2	A3	A4	A5	A6	A7	8	9	10	11
HT12F	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11

Oscillator frequency vs supply voltage


Note: The recommended oscillator frequency is f_{oscD} (decoder) $\cong 50 f_{oscE}$ (HT12E encoder)
 $\cong \frac{1}{3} f_{oscE}$ (HT12A encoder).



HT12A/HT12E 2¹² Series of Encoders

Features

- Operating voltage
 - 2.4V~5V for the HT12A
 - 2.4V~12V for the HT12E
- Low power and high noise immunity CMOS technology
- Low standby current: 0.1μA (typ.) at V_{DD}=5V
- HT12A with a 38kHz carrier for infrared transmission medium
- Minimum transmission word
 - Four words for the HT12E
 - One word for the HT12A
- Built-in oscillator needs only 5% resistor
- Data code has positive polarity
- Minimal external components
- HT12A/E: 18-pin DIP/20-pin SOP package

Applications

- Burglar alarm system
- Smoke and fire alarm system
- Garage door controllers
- Car door controllers
- Car alarm system
- Security system
- Cordless telephones
- Other remote control systems

General Description

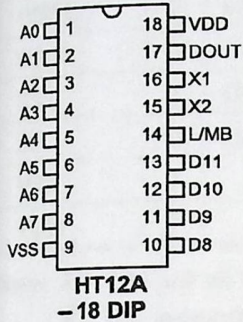
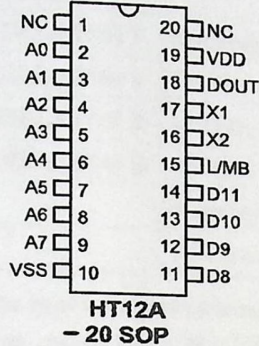
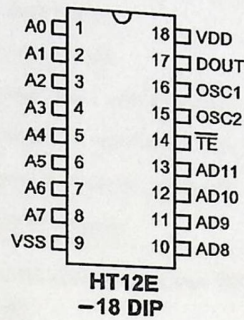
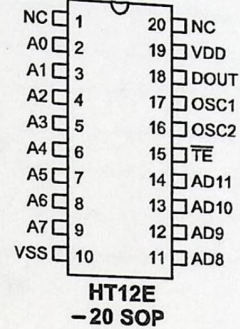
The 2¹² encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12-N data bits. Each address/data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits

via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a \overline{TE} trigger on the HT12E or a DATA trigger on the HT12A further enhances the application flexibility of the 2¹² series of encoders. The HT12A additionally provides a 38kHz carrier for infrared systems.

Selection Table

Function Part No.	Address No.	Address/ Data No.	Data No.	Oscillator	Trigger	Package	Carrier Output	Negative Polarity
HT12A	8	0	4	455kHz resonator	D8~D11	18 DIP 20 SOP	38kHz	No
HT12E	8	4	0	RC oscillator	\overline{TE}	18 DIP 20 SOP	No	No

Note: Address/Data represents pins that can be address or data according to the decoder requirement.

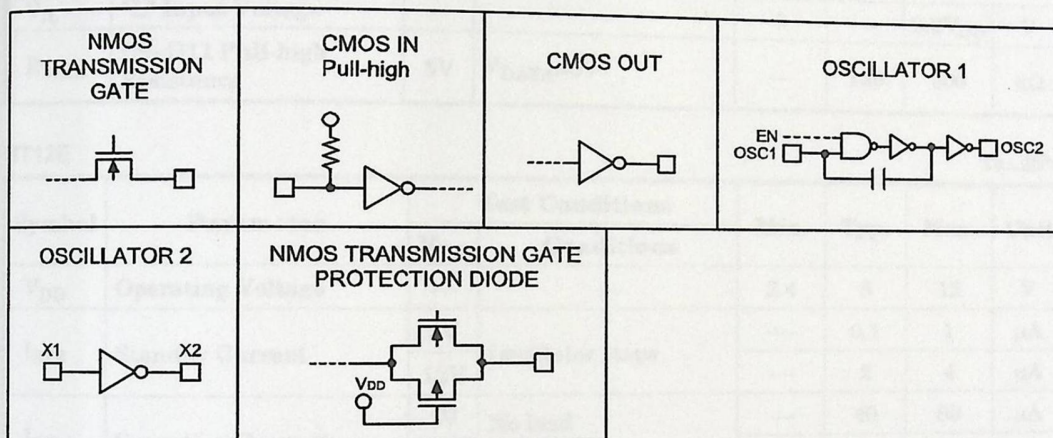
Pin Assignment
**8-Address
4-Data**

**8-Address
4-Data**

**8-Address
4-Address/Data**

**8-Address
4-Address/Data**

Pin Description

Pin Name	I/O	Internal Connection	Description
A0~A7	I	CMOS IN Pull-high (HT12A)	Input pins for address A0~A7 setting These pins can be externally set to VSS or left open
		NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)	
AD8~AD11	I	NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)	Input pins for address/data AD8~AD11 setting These pins can be externally set to VSS or left open
D8~D11	I	CMOS IN Pull-high	Input pins for data D8~D11 setting and transmission enable, active low These pins should be externally set to VSS or left open (see Note)
DOUT	O	CMOS OUT	Encoder data serial transmission output
L/MB	I	CMOS IN Pull-high	Latch/Momentary transmission format selection pin: Latch: Floating or VDD Momentary: VSS

Pin Name	I/O	Internal Connection	Description
\overline{TE}	I	CMOS IN Pull-high	Transmission enable, active low (see Note)
OSC1	I	OSCILLATOR 1	Oscillator input pin
OSC2	O	OSCILLATOR 1	Oscillator output pin
X1	I	OSCILLATOR 2	455kHz resonator oscillator input
X2	O	OSCILLATOR 2	455kHz resonator oscillator output
VSS	I	—	Negative power supply, grounds
VDD	I	—	Positive power supply

Note: D8~D11 are all data input and transmission enable pins of the HT12A.
 \overline{TE} is a transmission enable pin of the HT12E.

Approximate internal connections



Absolute Maximum Ratings

Supply Voltage (HT12A)	-0.3V to 5.5V	Supply Voltage (HT12E)	-0.3V to 13V
Input Voltage.....	$V_{SS}-0.3$ to $V_{DD}+0.3V$	Storage Temperature.....	-50°C to 125°C
Operating Temperature.....	-20°C to 75°C		

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

Electrical Characteristics
HT12A

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DD}	Operating Voltage	.....	.....	2.4	3	5	V
I _{STB}	Standby Current	3V	Oscillator stops	—	0.1	1	μA
		5V		—	0.1	1	μA
I _{DD}	Operating Current	3V	No load f _{OSC} =455kHz	.....	200	400	μA
		5V		—	400	800	μA
I _{DOUT}	Output Drive Current	5V	V _{OH} =0.9V _{DD} (Source)	-1	-1.6	—	mA
			V _{OL} =0.1V _{DD} (Sink)	2	3.2	—	mA
V _{IH}	"H" Input Voltage	—	—	0.8V _{DD}	—	V _{DD}	V
V _{IL}	"L" Input Voltage	—	—	0	—	0.2V _{DD}	V
R _{DATA}	D8~D11 Pull-high Resistance	5V	V _{DATA} =0V	—	150	300	kΩ

HT12E

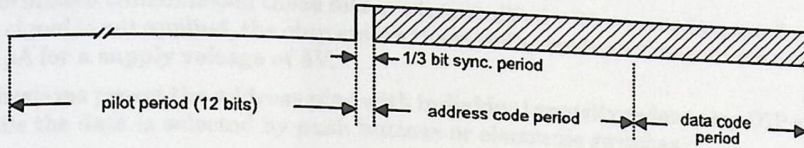
Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DD}	Operating Voltage	—	—	2.4	5	12	V
I _{STB}	Standby Current	3V	Oscillator stops	—	0.1	1	μA
		12V		—	2	4	μA
I _{DD}	Operating Current	3V	No load f _{OSC} =3kHz	—	40	80	μA
		12V		—	150	300	μA
I _{DOUT}	Output Drive Current	5V	V _{OH} =0.9V _{DD} (Source)	-1	-1.6	—	mA
			V _{OL} =0.1V _{DD} (Sink)	1	1.6	—	mA
V _{IH}	"H" Input Voltage	—	—	0.8V _{DD}	—	V _{DD}	V
V _{IL}	"L" Input Voltage	—	—	0	—	0.2V _{DD}	V
f _{OSC}	Oscillator Frequency	5V	R _{OSC} =1.1MΩ	—	3	—	kHz
R _{TE}	$\overline{\text{TE}}$ Pull-high Resistance	5V	V _{TE} =0V	—	1.5	3	MΩ

April 11, 2000

Information word

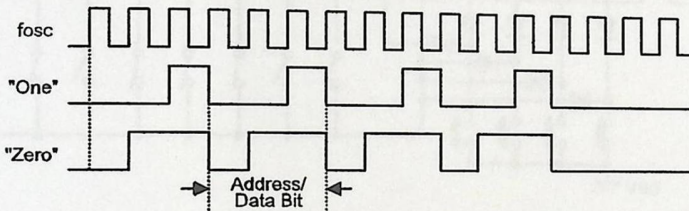
If $L/MB=1$ the device is in the latch mode (for use with the latch type of data decoders). When the transmission enable is removed during a transmission, the DOUT pin outputs a complete word and then stops. On the other hand, if $L/MB=0$ the device is in the momentary mode (for use with the momentary type of data decoders). When the transmission enable is removed during a transmission, the DOUT outputs a complete word and then adds 7 words all with the "1" data code. An information word consists of 4 periods as illustrated below.



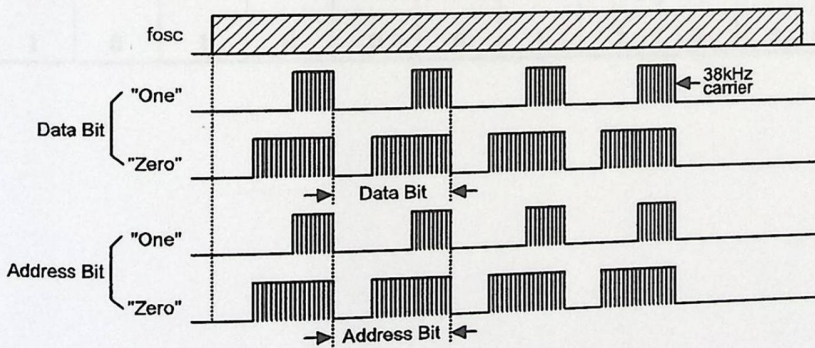
Composition of information

Address/data waveform

Each programmable address/data pin can be externally set to one of the following two logic states as shown below.



Address/Data bit waveform for the HT12E



Address/Data bit waveform for the HT12A

The address/data bits of the HT12A are transmitted with a 38kHz carrier for infrared remote controller flexibility.

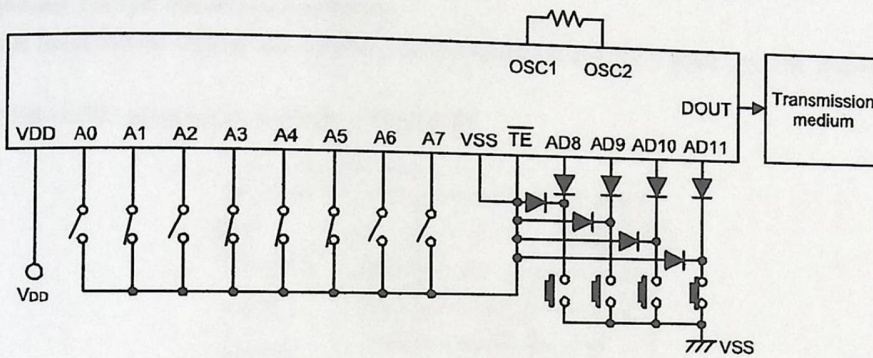
Address/data programming (preset)

The status of each address/data pin can be individually pre-set to logic "high" or "low". If a transmission-enable signal is applied, the encoder scans and transmits the status of the 12 bits of address/data serially in the order A0 to AD11 for the HT12E encoder and A0 to D11 for the HT12A encoder.

During information transmission these bits are transmitted with a preceding synchronization bit. If the trigger signal is not applied, the chip enters the standby mode and consumes a reduced current of less than 1µA for a supply voltage of 5V.

Usual applications preset the address pins with individual security codes using DIP switches or PCB wiring, while the data is selected by push buttons or electronic switches.

The following figure shows an application using the HT12E:



The transmitted information is as shown:

Pilot & Sync.	A0	A1	A2	A3	A4	A5	A6	A7	AD8	AD9	AD10	AD11
	1	0	1	0	0	0	1	1	1	1	1	0

Address/Data sequence

The following provides the address/data sequence table for various models of the 2¹² series of encoders. The correct device should be selected according to the individual address and data requirements.

Part No.	Address/Data Bits											
	0	1	2	3	4	5	6	7	8	9	10	11
HT12A	A0	A1	A2	A3	A4	A5	A6	A7	D8	D9	D10	D11
HT12E	A0	A1	A2	A3	A4	A5	A6	A7	AD8	AD9	AD10	AD11

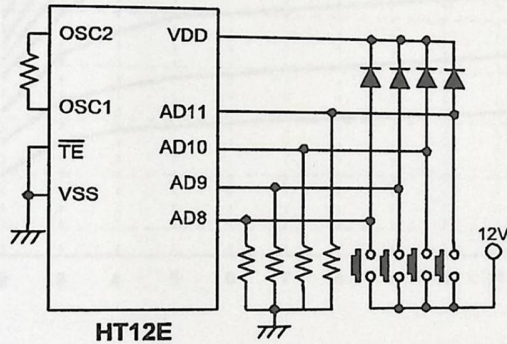
Transmission enable

For the HT12E encoders, transmission is enabled by applying a low signal to the \overline{TE} pin. For the HT12A encoders, transmission is enabled by applying a low signal to one of the data pins D8-D11.

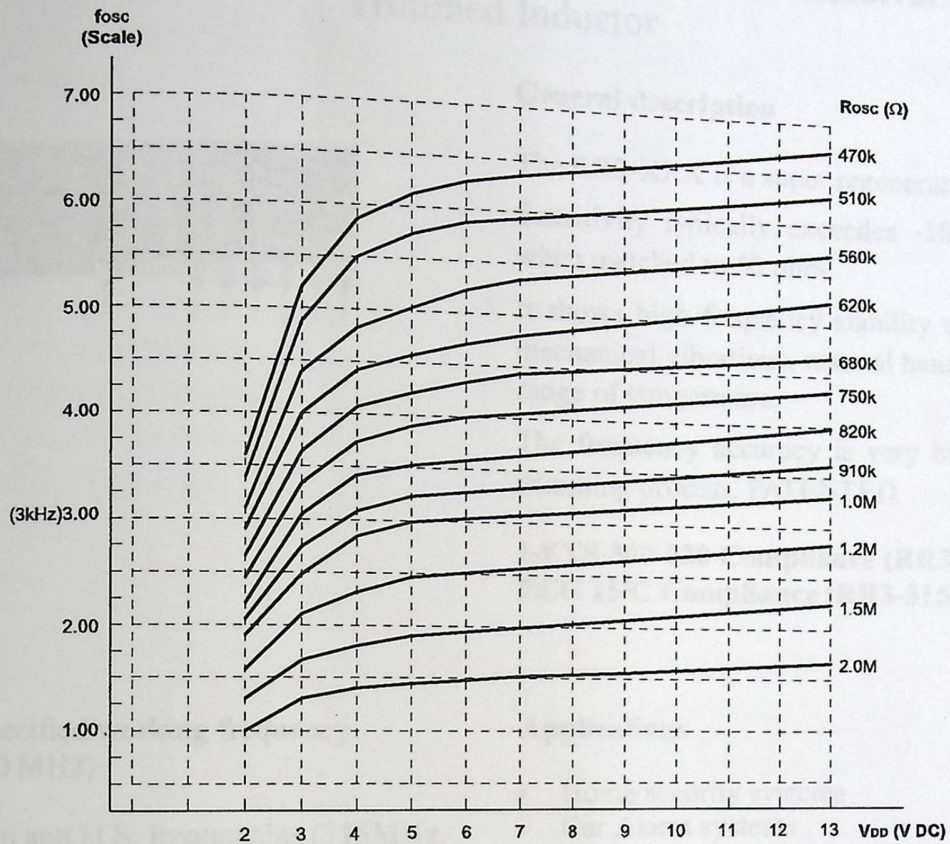
Two erroneous HT12E application circuits

The HT12E must follow closely the application circuits provided by Holtek (see the "Application circuits").

- Error: AD8~AD11 pins input voltage > V_{DD}+0.3V



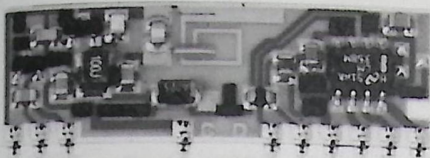
Oscillator frequency vs supply voltage



The recommended oscillator frequency is f_{OSCD} (decoder) $\cong 50 f_{OSCE}$ (HT12E encoder)
 $\cong \frac{1}{3} f_{OSCE}$ (HT12A encoder)

RR3-XXX

Super Regenerative Radio Receiver With Laser Trimmed Inductor



General description

The RR3-XXX is a super regenerative data receiver. Sensitivity typically exceeds -100dBm ($2.2\mu\text{Vrms}$) when matched to $50\ \Omega$.

It shows high frequency stability also in presence of mechanical vibrations, manual handling and in a wide range of temperature.

The frequency accuracy is very high thanks to laser trimming process. PATENTED.

I-ETS 300-220 Compliance (RR3-418, RR3-433.92)
FCC 15/C Compliance (RR3-315)

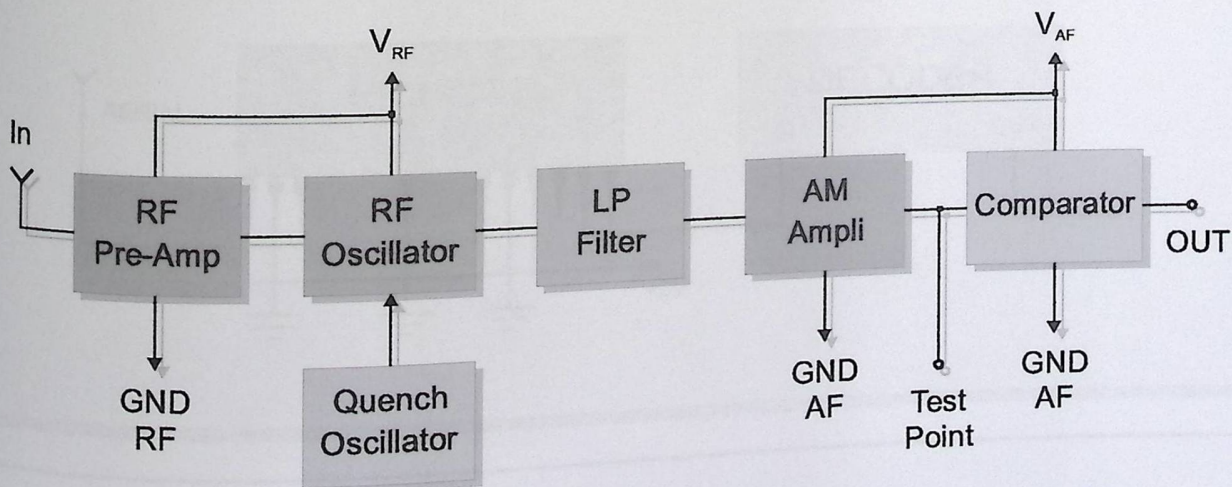
XXX: custom-specified working frequency
 (200 ÷ 450 MHz)

Standard European and U.S. frequencies (315MHz, 433.92MHz) are readily available from stock.

Applications

- Home security systems
- Car Alarm systems
- Remote gate controls
- Sensor reporting

BLOCK DIAGRAM



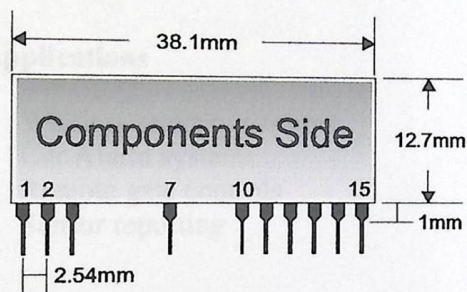
Electrical Characteristics

CHARACTERISTICS		Ta = 25°C unless otherwise specified			
		MIN	TYP	MAX	UNIT
V _{RF}	RF Supply Voltage	4.5	5	5.5	VDC
V _{AF}	AF Supply Voltage	4.5	5	5.5	VDC
I _S	Supply Current		2.5	3	mA
F _W	Working Frequency	200		450	MHz
	Tuning Tolerance		±0.2	±0.5	MHz
B _W	-3dB Bandwidth		±2	±3	MHz
	Max Data Rate			2	KHz
	RF Sensitivity (100% AM)	-100	-105		dBm
	Level of Emitted Spectrum		-65		dBm
V _{cl}	Low-Level Output Voltage			0.6	V
V _{oh}	High-Level Output Voltage	3.6			V
T _{OP}	Operating Temperature Range	-25		+80	°C

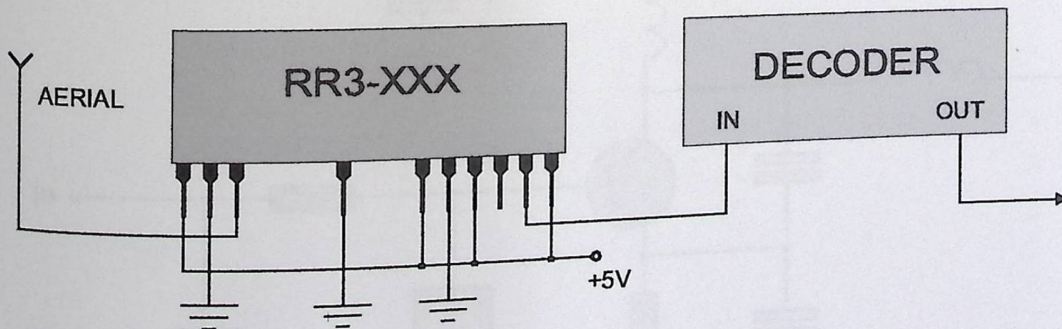
Pin Description

1	RF +V _{CC}	9	NC
2	RF GND	10	AF +V _{CC}
3	IN	11	AF GND
4	NC	12	AF +V _{CC}
5	NC	13	Test Point
6	NC	14	OUT
7	RF GND	15	AF +V _{CC}
8	NC		

Mechanical Dimensions



TYPICAL APPLICATION



RT4-XXX

Radio Transmitter Module with SAW Resonator and External Antenna



General description

The RT4-XXX is an hybrid circuit that allows to realize a complete radio transmitter adding a coding circuit.

It shows stable electric characteristics thanks to the "Thick film hybrid" technology.

XXX : working frequency (315, 418, 433.92 MHz)

I-ETS 300 220 Compliance (RT4-433.92-IETS)

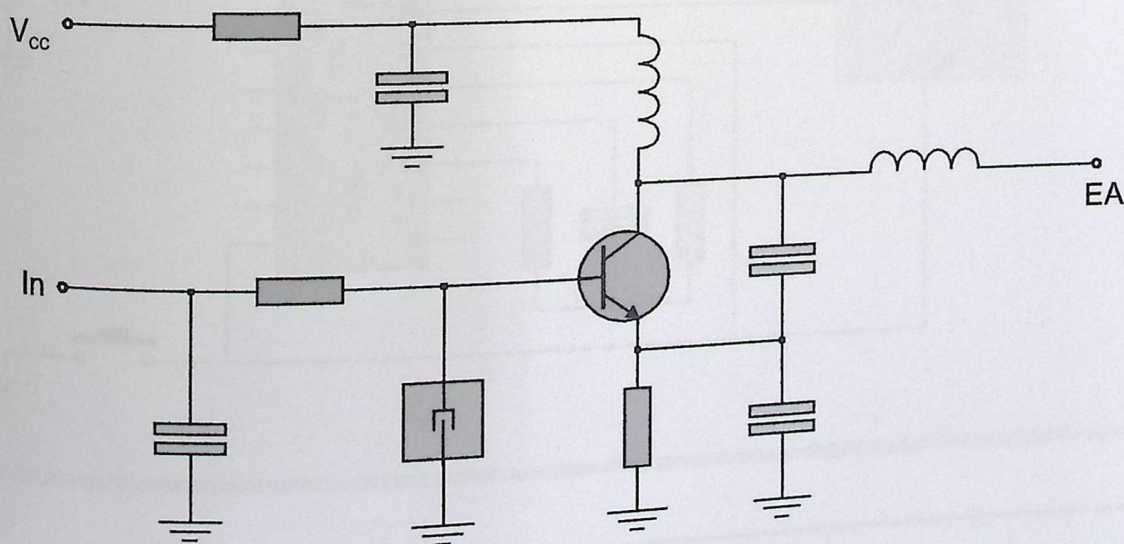
Features

- High Reliability
- DIL Package

Applications

- Wireless security systems
- Car Alarm systems
- Remote gate controls
- Sensor reporting

CIRCUIT SCHEMATIC



CHARACTERISTICS

Ta = 25°C unless otherwise specified

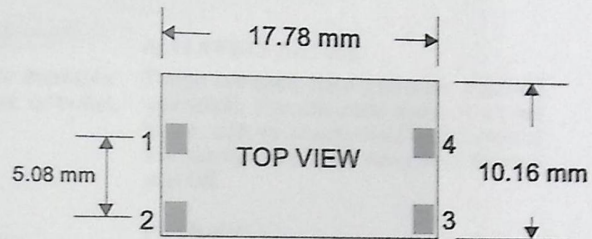
	MIN	TYP	MAX	UNIT
Supply Voltage	2			VDC
Supply Current (Vcc=5V IN=1KHz Square Wave)		4	14	mA
Working Frequency	303.8		433.92	MHz
RF Output Power into 50Ω (Vi=5V, Vcc=12V)		7	10	dBm
Harmonic Spurious Emission		-30		dBc
Input High Voltage	2		V _{cc}	V
Max Data Rate			4	KHz
Operating Temperature Range	-25		+80	°C

Equipment utilizing this device requires emissions testing and government approval, which is the responsibility of the equipment manufacturer.

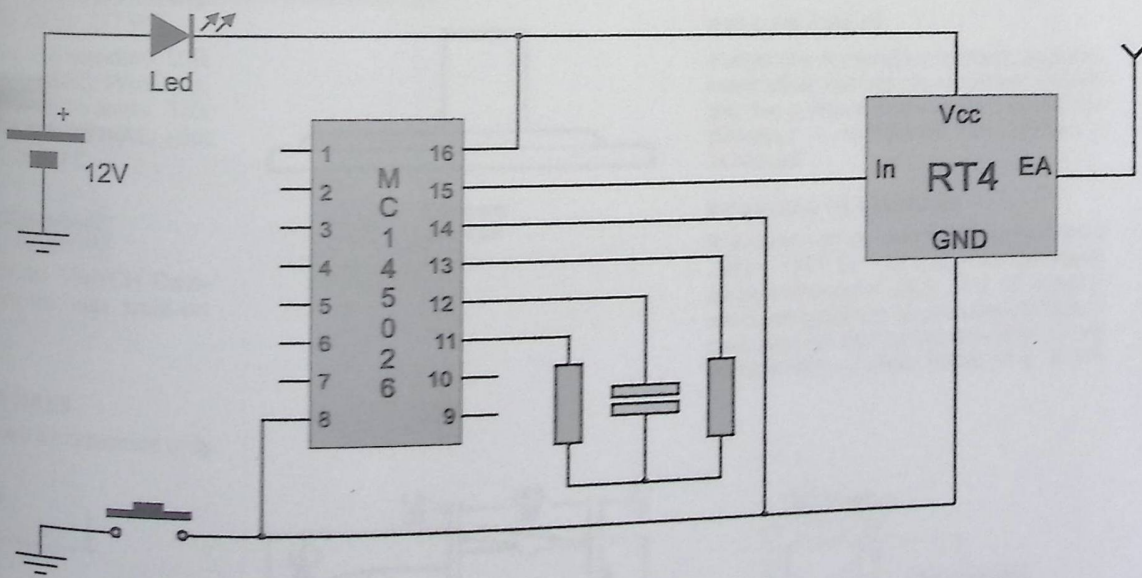
Description

- V_{cc} Supply Voltage
- GND Ground
- IN Modulation Input
- EA External Antenna

Mechanical Dimensions



TYPICAL APPLICATION



Electrical Characteristics

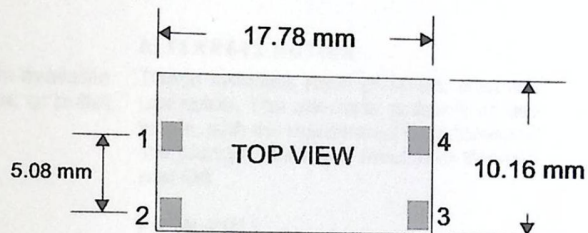
CHARACTERISTICS		Ta = 25°C unless otherwise specified			
		MIN	TYP	MAX	UNIT
V _{CC}	Supply Voltage	2			VDC
I _S	Supply Current (V _{CC} =5V IN=1KHz Square Wave)		4	14	mA
F _W	Working Frequency	303.8		433.92	MHz
P _O	RF Output Power into 50Ω (Vi=5V, V _{CC} =12V)		7	10	dBm
V _{IH}	Input High Voltage		-30		dBc
	Max Data Rate	2		V _{CC}	V
T _{OP}	Operating Temperature Range	-25		4	KHz
				+80	°C

Typically, equipment utilizing this device requires emissions testing and government approval, which is the responsibility of the equipment manufacturer.

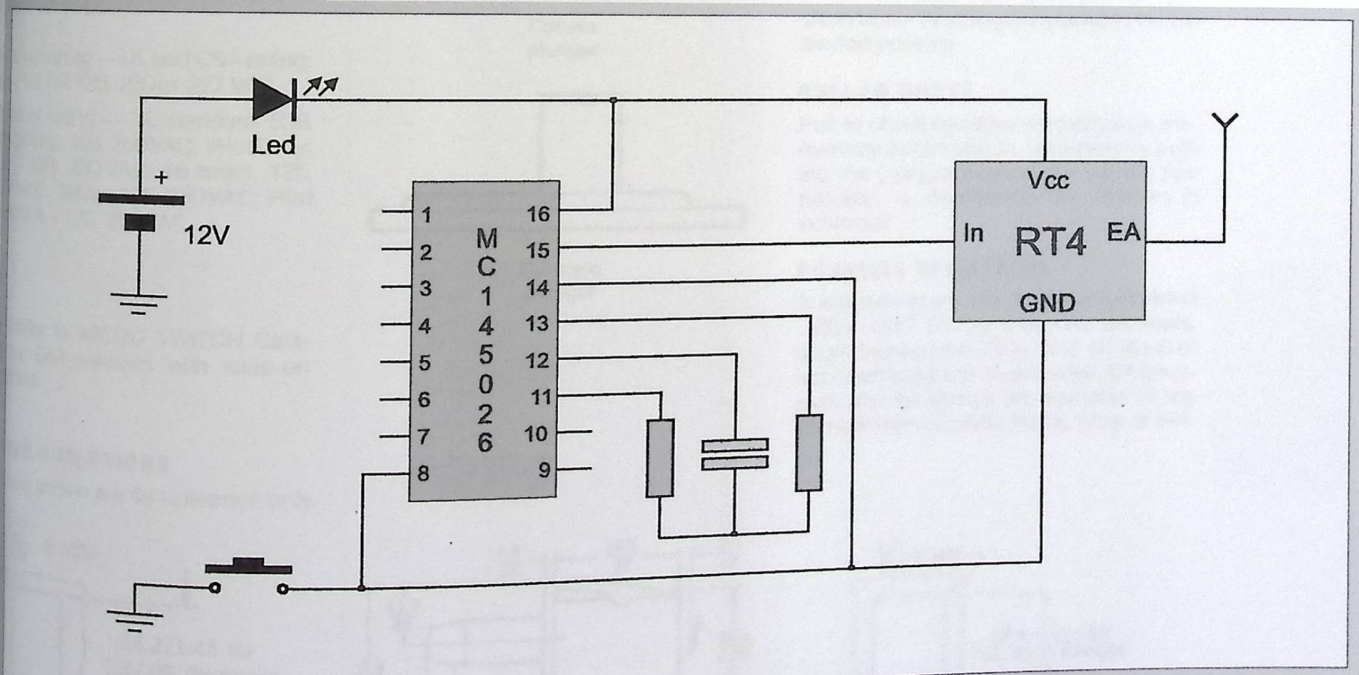
Pin Description

1	V _{CC}	Supply Voltage
2	GND	Ground
3	IN	Modulation Input
4	EA	External Antenna

Mechanical Dimensions



TYPICAL APPLICATION



Switches -in Panel Mount

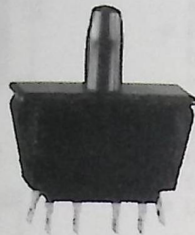
DM/DP Series

Momentary Action



Bulletnose plunger (SPDT shown)

Alternate Action



Bulletnose plunger (DPDT shown)

Push-Pull

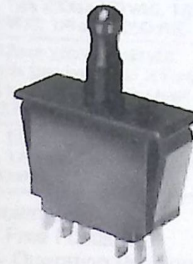


Finger grip plunger (DPDT shown)

Pull-to-Cheat



Finger grip plunger with flat tip (SPDT shown)



Finger grip plunger with spherical tip (DPDT shown)

FEATURES

Active, rugged snap-in panel mount design — easy installation
Choice of momentary, alternate push and pull-to-cheat operation
Quick-connect terminals
Expected mechanical life: 1 million operations, 95% survival
Temperature range: -35° to $+180^{\circ}$ F (-7° to 82° C)
UL recognized file # E 22779, CSA certified file # LR4442

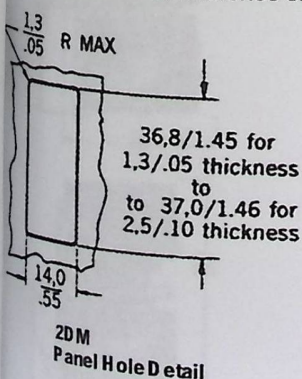
Electrical rating — UL and CSA rating: 1/2HP, 125, 250 or 277 VAC

Electrical rating — UL standard 508: 3/4hp, 125, 250VAC; Pilot Duty: 1/2 A - 125, 250 VAC; 16 amps, 125, 277 VAC, 3/4hp, 125, 250VAC; Pilot Duty: 1/2 A - 125, 250VAC.

Refer to MICRO SWITCH Catalog for DM switches with snap-on buttons.

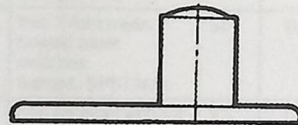
MOUNTING DIMENSIONS

Dimensions shown are for reference only.

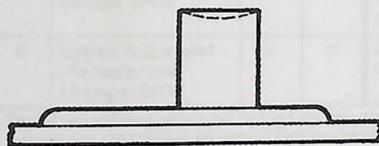


MOMENTARY ACTION

Momentary action switches are available in a choice of concave, convex, or bullet nose plunger styles.



Convex plunger



Concave plunger

ALTERNATE ACTION

These switches have push-on, push-off operation. The alternate action is at two levels, with the maintained On position of the plunger at a lower level than the normal Off.

PUSH-PULL

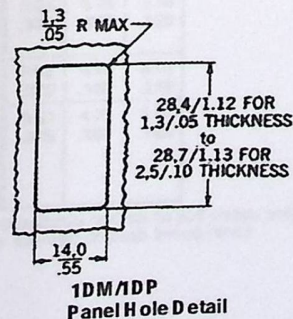
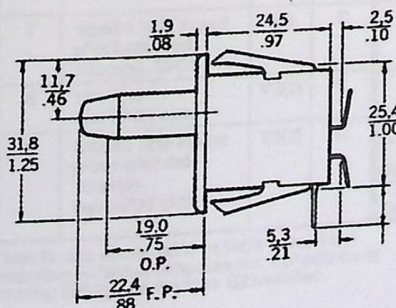
When plunger is depressed, it remains down and maintains circuit transfer. Switch contacts return to the previous position when the plunger is pulled to the extended position.

PULL-TO-CHEAT

Pull-to-cheat operates normally as a momentary action switch. However, by pulling the plunger beyond the normal free position, a maintained On position is achieved.

POSSIBLE VARIATIONS

In addition to the standard quick-connect .188 x .020" (4.78 x 0.51 mm) terminals, angled forms and .250 x .032" (6.35 x 0.81 mm) terminals can be provided. DM plungers and faceplates are available in any combination of white, black, gray, or red.



Switches

AC Series

FEATURES

- Automatically cut power when service door or drawer is opened, helping protect personnel and equipment
- Enables circuit testing with power On by manually pulling rod actuator to maintained-On position. (Closing door or drawer resets switch.)
- Basic switches are component recognized by UL to UL1054 special use switches.
- UL recognized AC are available

ELECTRICAL RATINGS

A	15 amps, 125, 250 or 480 VAC; 1/2 amp, 125 VDC; 1/4 amp, 250 VDC.
B	5 amps, 125 or 250 VAC; 30 VDC ind., 3 amps (sea level) and 2.5 amps (50,000 ft.); res., 5 amps (sea level and 50,000 ft.); max. inrush 25 amps.
C	15 amps, 125 or 250 VAC; 1/2 amp, 125 VDC; 1/4 amp, 250 VDC; 1/3 hp, 125 or 250 VAC.

Characteristics:
 F.P. — Free Position;
 O.P. — Operating Position;
 D.P. — Depressed Position.

ORDER GUIDES WITH STEEL ROD ACTUATORS

Style No.	Description	Basic Switch	Elec. Rating	Catalog Listing	F.P. max. mm In.	O.P. min. mm In.	D.P. max. mm In.	Temp. Ratings
1	15 amps, SPDT.	BZ	A	1AC2	11.1 .438	6.35 .250	3.18 .125	-65°F to +180°F
2	5 amps, Four SPDT ckts.	SM(4)	B	8AC1	9.53 .375	5.16 .203	3.18 .125	-65°F to +250°F
3	Three 6-foot leads. Sealed basic switches 5 amps, SPDT	SE	B	9AC4	9.53 .375	5.16 .203	3.18 .125	-65°F to +221°F
3	Two 3-foot leads. Sealed basic switches. 5 amps, SPST-N.O.	SE	B	9AC12-3	9.53 .375	5.16 .203	3.18 .125	-65°F to +221°F
4	Can be reset without momentary ckt break. 15 amps, SPDT.	V3	C	13AC1	15.9 .625	12.3 .485	6.68 .263	-67°F to +300°F
5	Miniature size. 5 amps, SPDT	SM	B	17AC1-T 17AC18-T† (MS16106-4)	9.53 .375	5.59 .220	4.45 .175	-65°F to +250°F -67°F to +185°F
6	Tapped hole in end of actuator rod. 15 amps, SPDT.	V3	C	2AC59† (MS16106-1)	9.53 .375	5.16 .203	3.18 .125	-67°F to +185°F

†—These are military approved listings and the temperature range shown is for the finished product. All other listings are not military approved and the temperature range shown is the range for the basic switch only.

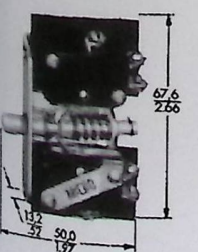
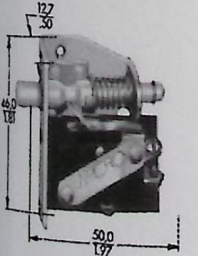
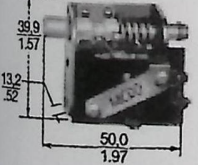
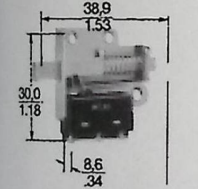
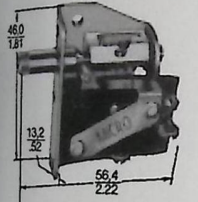
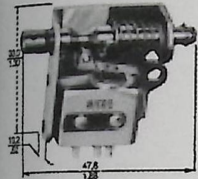
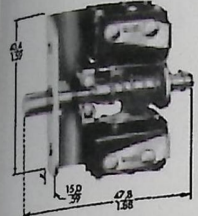
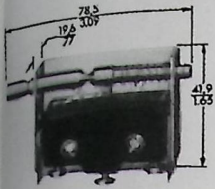
WITH HIGH STRENGTH THERMOPLASTIC ROD ACTUATORS*

2	5 amps. Four SPDT ckts.	SM(4)	B	8AC9 (MS16106-3)	9.53 .375	5.16 .203	3.18 .125
6	15 amps. SPDT.	V3	C	22AC1	9.53 .375	5.16 .203	3.18 .125
6	Tapped hole in end of actuator rod. 15 amps. SPDT.	V3	C	22AC2	9.53 .375	5.16 .203	3.18 .125
7	15 amps. SPDT.	V3	C	23AC1	9.53 .375	5.16 .203	3.18 .125
7	Tapped hole in end of actuator rod. 15 amps. SPDT.	V3	C	23AC2	9.53 .375	5.16 .203	3.18 .125
8	15 amps. Two SPDT ckts.	V3(2)	C	24AC1	9.53 .375	4.75 .187	3.18 .125
8	Tapped hole in end of actuator rod. 15 amps. Two SPDT ckts.	V3(2)	C	24AC2 4AC54** (MS16106-2) 4AC55 (MS16106-5)	9.53 .375	4.75 .187	3.18 .125

*Not for use above 85°C (+185°F). Use steel actuators at higher temperatures. For additional catalog listings, contact the 800 number.

**Both switches operate on pull stroke, only one switch operates on push (reset) stroke.

Sealed/High Temperature



```
package part;

import java.awt.Color;
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;

public class ParallelThread {
```

```
    private int i;

    public ParallelThread(int i) {
        this.i = i;
    }
}
```

```
    public void run() {
```

```
        while(i > 0) {
```

```
            System.out.println("ParallelThread: " + i);
```

```
            i--;
```

```
        }
    }
}
```

```
try {
    Thread.sleep(100);
} catch (InterruptedException e) {
    System.out.println("InterruptedException");
}
```

```
public void actionPerformed(ActionEvent e) {
```

```
    if (e.getSource() == btnRun) {
```

```
        try {
            Thread.sleep(100);
        } catch (InterruptedException e1) {
            System.out.println("InterruptedException");
        }
    }
}
```

```
    if (e.getSource() == btnStop) {
```

```
        System.out.println("ALARM");
    }
}
```

Appendix B:

Source Code

```

package port;

import java.awt.Color;
import javax.swing.JOptionPane;

public class readThread extends Thread{

    parallelPort p;

    public readThread() {
        p = new parallelPort();
        this.start();
    }

    public void run(){

        while(true){

            if (alarmEnabled){
                warningOn=false;
                alarmOn=false;
                //this.alterMainFrame();
                this.alterShowFrame();

                try {
                    Thread.sleep(100);
                } catch (Exception e) {
                    JOptionPane.showMessageDialog(null, "unable to sleep the thread");
                }
            }

        }

    public void alterShowFrame(){

        if (alarmOn){
            //showFrame.bg.setIcon(new
            javax.swing.ImageIcon(getClass().getResource("/img/aaa3.jpg")));
            showFrame.alarmLabel.setForeground(Color.RED);
            if (showLabel)
                showFrame.alarmLabel.setText("ALARM");
            else

```

```

        showFrame.alarmLabel.setText("");
        showLabel=!showLabel;
        alarmOn=true;

        if (writeToFile){
            //write action to log file
            logThread.writeToFile("ALARM ON");
            writeToFile=false;
        }

    }
    if (warningOn){
        //showFrame.largeImage.setIcon(new
        javax.swing.ImageIcon(getClass().getResource("/img/aaa2.jpg")));
        showFrame.alarmLabel.setForeground(Color.RED);

        if (showLabel)
            showFrame.alarmLabel.setText("WARNING");
        else
            showFrame.alarmLabel.setText("");
        showLabel=!showLabel;
        alarmOn=false;

        if (writeToFile){
            //write action to log file
            logThread.writeToFile("WARNING ON");
            writeToFile=false;
        }

    }
    if (alarmOn==false && warningOn==false){
        //mainFrame.largeImage.setIcon(new
        javax.swing.ImageIcon(getClass().getResource("/img/aaal.jpg")));
        showFrame.alarmLabel.setForeground(Color.BLUE);

        showFrame.alarmLabel.setText("No intrusion");
        writeToFile=true;
    }
}

public static boolean writeToFile=true;
public static boolean alarmAndWarn=true;
public static boolean alarmOn=false;
public static boolean alarmEnabled=true;

```

```
public static boolean warningOn=false;
public static boolean showLabel=true;
```

```
}
```

```
package port;
```

```
import java.io.BufferedWriter;
import java.io.File;
import java.io.FileWriter;
import java.util.Calendar;
import javax.swing.JFileChooser;
```

```
public class logThread extends Thread{
```

```
    public static boolean showLabel=true;
```

```
    public static File f1;
    public static FileWriter fWrite;
    public static BufferedWriter writer=null;
```

```
    public static Calendar cc;
```

```
    public logThread() {
```

```
        cc=Calendar.getInstance();
```

```
        String filePath=this.setPath();
        //javax.swing.JOptionPane.showMessageDialog(null,">>" +filePath+"<<");
```

```
        try {
```

```
            f1=new File(filePath);
            fWrite=new FileWriter(f1);
            writer=new BufferedWriter(fWrite);
```

```

        String time= cc.get(Calendar.DAY_OF_MONTH) + "/" +
(cc.get(Calendar.MONTH)+1) + "/" + cc.get(Calendar.YEAR) + " " +
cc.get(Calendar.HOUR_OF_DAY)+":"+cc.get(Calendar.MINUTE);
        writer.write("Logging started at: " + time);
        writer.write("\r\n");

        writer.close();

        showFrame.loggingLabel.setText("Logging --> " + time);
    } catch (Exception e){
        System.out.println(e.toString());
    }
}

public static void writeToFile(String line){
    try {

        fWrite=new FileWriter(f1,true);
        writer=new BufferedWriter(fWrite);

        writer.write(cc.get(Calendar.DAY_OF_MONTH) + "/" +
(cc.get(Calendar.MONTH)+1) + "/" + cc.get(Calendar.YEAR) + " " +
cc.get(Calendar.HOUR_OF_DAY)+":"+cc.get(Calendar.MINUTE)+" --> ");
        writer.write(line);
        writer.write("\r\n");

        writer.close();

    } catch (Exception e) {
        System.out.println(e.toString());
    }
}

private static String setPath(){
    JFileChooser jF=new JFileChooser();

    jF.showSaveDialog(null);

    return jF.getSelectedFile().getPath();
}
}

```

```

}

/*
 *
 * this class is the main class used for all the operations that relates to the parallel
port
 * for reading and writing values to the port and other things related to it are
implemented
 * here.
 */

//import java.lang.Integer;

package port;

import hardware.jnpout32.ioPort;

public class parallelPort{

// Class constant Definition .....

public final static short D0 = 1; // 2^0
public final static short D1 = 2; // 2^1
public final static short D2 = 4; // 2^2
public final static short D3 = 8; // 2^3
public final static short D4 = 16; // 2^4
public final static short D5 = 32; // 2^5
public final static short D6 = 64; // 2^6
public final static short D7 = 128; // 2^7

public final static short S3 = 8; // 2^3
public final static short S4 = 16; // 2^4
public final static short S5 = 32; // 2^5
public final static short S6 = 64; // 2^6
public final static short S7 = -128; // - 2^7 ... minus sign is because the line is
active low

public final static boolean ON = true; // used to notify that the value is high 5V
public final static boolean OFF = false; // used to notify that the value is low 0V

final static short DATA_ADDRESS = (short)0x378; // address of the parallel
port data lines

```

```

final static short STATUS_ADDRESS = (short)0x379; // address of the parallel
port status lines

// Data Variable Defintions .....
ioPort port = new ioPort(); // instance of the native class of the parallel
port
short outputValue = 0; // current output value in the parallel port

// constructors.....
public void parallelPort(){
// set all output bits of the parallel port to zero
// reset all values of the parallel port
ioPort port = new ioPort();
outputValue = 0; //set output value of the data lines to zero
refreshOutput(); //resend the value of the outputValue to the data lines of the
port
}

public void parallelPort(short output){
ioPort port = new ioPort();
outputValue = output; //set output value of the data lines to the user sent one
refreshOutput(); //resend the value of the outputValue to the data lines of the
port
}

// methods related to the status lines of the parallel port.....

private boolean getPinValue(short pin){
// the pin must be an acceptable pin from S3 - S7 only

// pin S7 is a special case of the parallel port since its active low
if(pin == S7){
short value = port.Inp32(STATUS_ADDRESS);
int maskResult = value & 128;

if(maskResult == 128)
return OFF;
else
return ON;
}

if(isStatusPin(pin)){

```

```

// read the
short value = port.Inp32(STATUS_ADDRESS);
int maskResult = value & pin;

if(maskResult == pin)
    return ON;
else
    return OFF;
}

// if the pin is not a status line then return an OFF value
return OFF;
}

public boolean isPinOn(short pin){
    return getPinValue(pin);
}

public boolean isPinOff(short pin){
    return !getPinValue(pin);
}

public boolean isAllStatusPinsOn(){
    // when all status pins in the parallel port are off the value must be 128 wich is the
    // complement
    // of the last bit in it S7

    if(port.Inp32(STATUS_ADDRESS) == 128)
        return true;
    else
        return false;
}

public boolean isAllStatusPinsOff(){
    // when all status pins in the parallel port are on the value must be 127 wich is the
    // complement
    // of the last bit in it S7

    if(port.Inp32(STATUS_ADDRESS) == 127)
        return true;
    else
        return false;
}

```

```

// methods related to the Data lines of the parallel port.....

public void setPinValue(short pin){
    // check if the sent pin is an acceptable data pin from D0-D7
    // and check if its already set or not !!!

    if(isDataPin(pin) && !isDataPinSet(pin)){
        outputValue += pin;    // set the corresponding bit value and then send it to the
port
        refreshOutput();
    }
}

public void resetPinValue(short pin){
    // check if the sent pin is an acceptable data pin from D0-D7
    // and check if its already reset or not !!!

    if(isDataPin(pin) && isDataPinSet(pin)){
        outputValue -= pin;    // reset the corresponding bit value and then send it to the
port
        port.Out32(DATA_ADDRESS,outputValue);
    }
}

public void setAllPins(){
    // set all pins of the parallel port
    outputValue = (short) 0xFF;
    refreshOutput();
}

public void resetAllPins(){
    // set all pins of the parallel port
    outputValue = (short) 0x00;
    refreshOutput();
}

public void refreshOutput(){
    //send the current outputValue to to the parallel port
    port.Out32(DATA_ADDRESS, outputValue);
}

public boolean isDataPinSet(short pin){

```

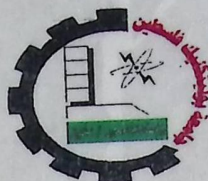
```
int maskResult = outputValue & pin;
if (maskResult == 0)
    return false;
else
    return true;
}

// private methods used within other methods of the parallel port.....

private boolean isStatusPin(short pin){
    // check if the pin is a status pin and return true if its else return a false
    if (pin == S3 || pin == S4 || pin == S5 || pin == S6 || pin == S7 )
        return true;
    else
        return false;
}

private boolean isDataPin(short pin){
    // check if the pin is a data pin and return true if its else return a false
    if (pin == D0 || pin == D1 || pin == D2 || pin == D3 || pin == D4 || pin == D5 || pin
    == D6 || pin == D7 )
        return true;
    else
        return false;
}
```

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